ملخص

Lab Physics (1)

إعداد: زينة منصور

ARCHITECTS BEYOND IMPOSSIBLE

* Experimental error and data analysis *

- Types of Errors :-

1- personal (illegitimate errors)

2- systematic errors

3- random errors (accidental error)

* parallax :- تغير واضح في الشيء (اتجاهه) ناتج عن تغير الوضع المتعلق بالمشاهدة

Accuracy / Precision

- Accuracy :- a measure of how close the experimental result comes to true value.

دقة/ خلو من الأخطاء

a measure of the correctness of the result.

* example 1 :- Two experimental results in the determination of the value of (π) .... the first is $\boxed{3.140}$ and the Second is $\boxed{3.143}$ .. Which result is more accurate? inspite that the true value is $\boxed{3.142}$

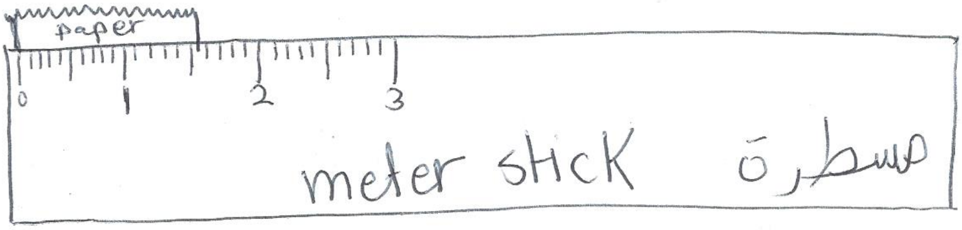
solution ⇒ The second result is more accurate than the first because it is more close to the accepted value .

- precision :- measure of its reliability or how reproducible the result is .

مقدار الخطأ (error) بالنتيجة

measure of the magnitude of uncertainity of the result

* example 2 :-



اقل تدريج فيها هو 1 mm

متى يمكن الخطأ في قراءة النتيجة ؟!!

⟸ اذا كان الحل (النتيجة) تحتوي على جزء المليمتر وبهذا يصعب تحديدها تماماً لذلك هنا يقع الخطأ

⟸ مقدار precision هنا يساوي اقل تدريج بالاداة المستخدمة * 0.5

$$precision = \frac{1}{2} * 1mm = 0.5 \, mm$$

* In general ⟹ precision (error in reading the result in any instrument = smallest devision * 0.5

* بشكل عام نعبر عن النتيجة (result) للتجربة

ب $X \pm precision$

مقدارها (الأرقام التي يمكن رؤيتها مباشرة)   مقدار الخطأ

فمثلاً في example 2 القراءة هي

15 ± 0.5 mm

* Example 3 هناك نتيجتين لتجربة مع مقدار الخطأ فيهم

وهما $(2.5 \pm 0.1\ cm)$ و $(2.5 \pm 0.2\ cm)$ بالترتيب

أي هاتين النتيجتين more accurate / precise ⇐

⇐ النتيجة الأولى هي أكثر دقة ومقدار الخطأ فيها أقل

⇐ the first is more accurate / precise

⇒ accuracy in general depends on systematic errors

⇒ precision in general depends on random errors

* Significant figures (digits)

⇒ is an experimental measurement include all the numbers that can be read directly from the instrument scale plus one doubtful or estimated number

⇐ هو قياس يتضمن جميع الأرقام التي نستطيع قراءتها مباشرة من أداة القياس بالإضافة إلى رقم مشكوك فيه أو غير أكيد.

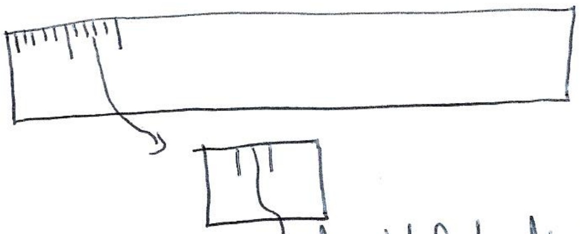
* rules of determining the significant figures

1. الرقم الموجود أقصى اليسار بشرط أنه ليس صفراً هو الأكثر أهمية

2. اذا لم يكن هناك فاصلة عشرية، الرقم الموجود أقصى اليمين بشرط أن لا يكون صفراً هو الأقل أهمية

3. اذا كان هناك فاصلة عشرية، الرقم الموجود أقصى اليمين حتى ولو كان صفراً هو الأقل أهمية

4. كل الأرقام الموجودة بين الرقم الأكثر أهمية وأقل أهمية، هم ذات أهمية



doubtful digit

* Example 4 (Using the rules)

1000. → 1 → most significant
0 → least significant
There are 4 significant digits

11.10 → 1 → most significant
0 → least significant
There are 4 significant digits

27.83 → 2 → most - -
3 → least - -
There are 4 significant figures

278300 → 2 → most -
3 → least - -
There are 4 significant digits

0.001230 → 1 → most - -
0 → least - -
There are 4 significant figures

* طبعا هون مرقة إنه -- 4 significant

* لدينا هذه النتيجة 4820

⇐ حسب القواعد إنه 0 ليس له أهمية ولكن بالحقيقة قد يكون له أهمية

ما الحل ؟!!

نكتبه على صورة $4.820 * 10^3$

⇐ $93,000,000$ mi ⇐ $9.300 * 10^7$ mi

---

* Errors

* Fractional error $= \dfrac{\text{absolute difference}}{\text{accepted value}} = \left|\dfrac{E - A}{A}\right|$

E → experimental value   A: Accepted (true) Value

⇐ إذا كان عنا أكثر من نتيجه فإن (E) هي Average

* percent Error = fractional error * 100 %

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

* نستخدم هذين القانونين إذا كنا نعلم القيمة الحقيقية A

* اذا لم نكن نعلم القيمة الحقيقية A نستخدم هذا القانون:-

$$\Rightarrow \text{Percent difference} = \frac{|E_2 - E_1|}{(E_2+E_1)/2} * 100\%$$

⇒ if there are more than 2 experimental values we find the percent difference by finding the absolute value of the difference of the extreme values and divid it by the average or mean value of the measurements.

$$= \frac{|E_{max} - E_{min}|}{(E_1+E_2+E_3 \dots + E_n)/n} * 100\%$$

Average (mean) Value

$$\bar{X} = \frac{X_1 + X_2 + X_3 + \dots + X_N}{N} = \frac{1}{N}\sum_{i=1}^{N} X_i$$

Deviation انحراف

$$d_i = x_i - \bar{x}$$

experiment value

mean (avg.) value

* Standard deviation $\Rightarrow \sqrt{\text{the variance } \sigma^2}$

$$\sigma^2 = \frac{1}{N}\sum_{i=1}^{N} d_i^2$$

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \bar{x})^2} = \sqrt{\frac{1}{N}\sum_{i=1}^{N} d_i^2}$$

square root of the Variance σ is called standard deviation

على الأغلب هذا القانون في الحل لا نعتمده

for small number of measurements $N<10$

$$\sigma = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N} d_i^2}$$

* standard deviation of the mean

$$\sigma_m = \sqrt{\frac{1}{N(N-1)}\sum_{i=1}^{N} d_i^2} \qquad N<10$$

هذا هو المعتمد في الحل

σ_m = precision = error

errors

one Value

$\frac{1}{2}$ * smallest scale

more than one value

standard deviation (σ_m)

هناك قوانين تعتمد على أكثر من قيمة
مثل الحجم (Volume)

$$V = \frac{\pi D^2 H}{4}$$

H → Height
D → Diameter
V → Volume

لإيجاد الخطأ في نتيجة قياس الحجم (V)

$$\Delta V = V \sqrt{\left(\frac{\Delta \pi}{\pi}\right)^2 + \left(\frac{\Delta D}{D}\right)^2 + \left(\frac{\Delta H}{H}\right)^2}$$

ΔV → الخطأ ، V → القيمة

* Rules

a) $R = X * Y$ or $R = X / Y$

$$\Delta R = R \sqrt{\left(\frac{\Delta X}{X}\right)^2 + \left(\frac{\Delta Y}{Y}\right)^2}$$

b) $R = X + Y$ or $X - Y$

$$\Delta R = \sqrt{(\Delta x)^2 + (\Delta y)^2}$$

c) $R = x^n$

$$\Delta R / R = n \left(\frac{\Delta X}{X}\right)$$

$$\Delta R = R * n \left(\frac{\Delta X}{X}\right)$$

---

* linear graphs

* The division on the horizontal axis must not be equal to a devision on the vertical axis

* choosing scales:-
It is alright to have 5 divisions, 20, 50, for each unit but never 3 or 7 or 9

$$\boxed{Y = mx + b}$$

b: y intercept

m: slope

$$Y - Y_0 = m(X - X_0)$$

$$m = \frac{Y_2 - Y_1}{X_2 - X_1}$$

* log-log graphs

$$Y = K x^m$$

$$\log_{10} Y = \log_{10} K + m \log_{10} X$$

$$\boxed{Y = b + mx}$$

* log-linear graphs

$$Y = K e^{cx}$$

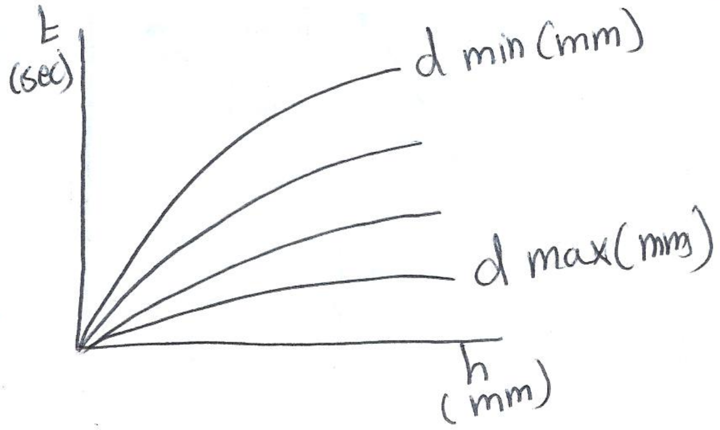
$$\log_{10} Y = cx \log_{10} e + \log_{10} K$$

$$\boxed{y = mx + b}$$

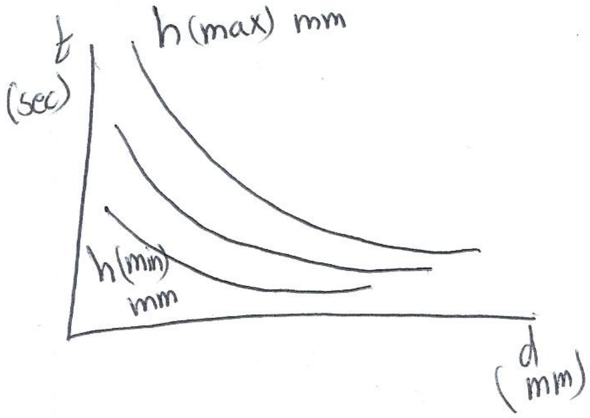
* Experiment 1 *
* Collection and analysis of Data *

(d) → diameter القطر
(h) → depth العمق/الارتفاع

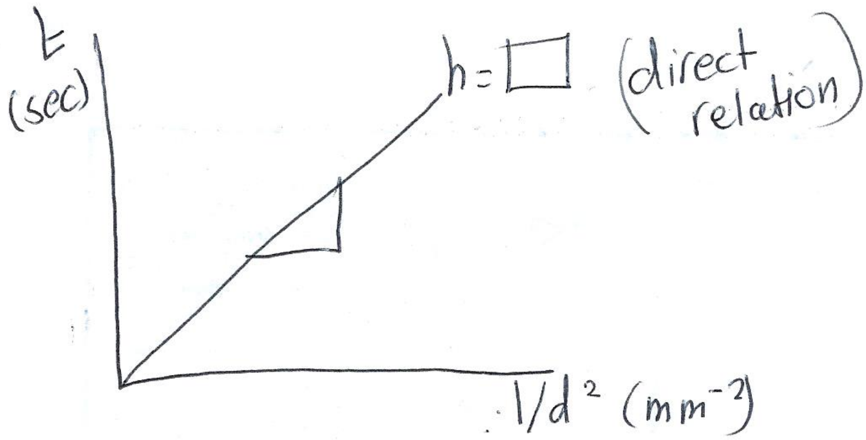
Dia. & h → independent Values
(T) Time → dependent Value

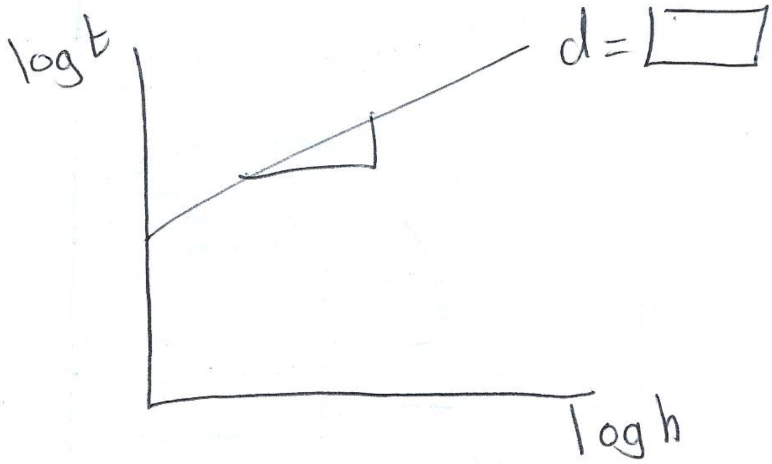


(inverse relation)
كلما زادت d احتاج
إلى وقت أقل لتفريغ
ال container

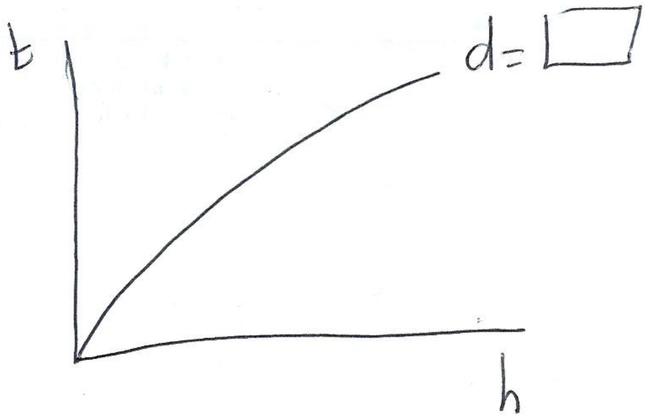


(direct relation)
كلما زاد h (الارتفاع)
فإنه لزم وقت اكبر لتفريغ
ال container





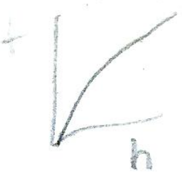
$\log t = m \log h + b$



⇒ it pass through the origin because there is no water in the container at $t=0$

$Y = 10^{b} x^{m}$ (log-log)

12



LAB REPORT FOR EXPERIMENT 1

Date: 3/10/2013

Name: Zeina Mansour

Partner's Name: Doaa Mhammad

Registration No: 0133014

Registration No: 013

Physics Section: 17

Instructor's Name: Dr. Alaa Al-Azam

PHYSICS LAB EXPERIMENT 1: COLLECTION AND ANALYSIS OF DATA

1. PURPOSE :

Collection and Analysis data

9.5/10

II. DATA :

Table (1.1)

d→mm

h (cm)	t in seconds			
	d = 1.5 mm	d= 2.0mm	d=3.0mm	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 inTable (1.1) fill in Table (1.2) below:

Table (1.2)

d (mm)	t in seconds			
	h = 30.0 cm	h=10.0cm	h=4.0cm	h=1.0cm
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

37.24

5.5317

for h = 30 cm , fill in Table 1.3 below:

Table(1.3)

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

for d = 2 mm fill in Table 1.4 below:

Table(1.4)

log t	log h
1.61	1.47
1.37	1
1.17	0.60
0.85	0

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 $\mathbf{1/d^2}$ for h = 30 cm

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

IV. CONCLUSIONS

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

Yes, because there is no water in the container

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

inverse relationship

5

3. From **t** versus **1/d²** graph, find the empirical relationship between time (t) and hole diameter (d) **for h =30 cm** .

$y = sx \pm b \Rightarrow t = 166.6(1/d^2) + 10$

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?**

$t = \frac{166.6}{16} = 0.103$ sec.

$t = \frac{166.6}{64} = 0.025$ sec.

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

$y = sx \pm b \rightarrow \log t = 0.5 (\log h) + 0.85$

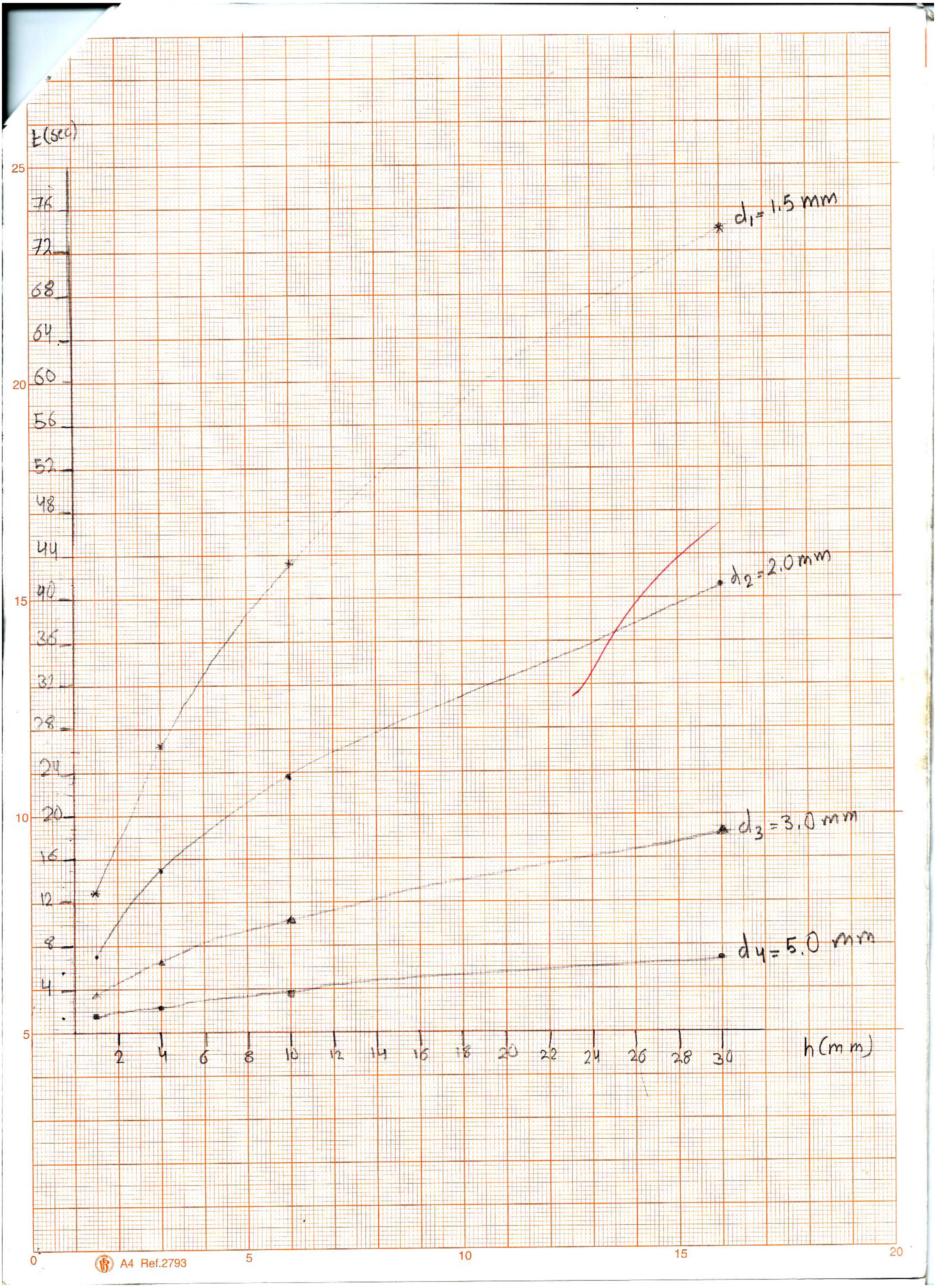
$\log t - 0.5(\log h) = 0.85 \Rightarrow \log \frac{t}{\sqrt{h}} = 0.85$

$\frac{t}{\sqrt{h}} = 10^{0.85} \rightarrow t = \sqrt{h} \times 10^{0.85}$

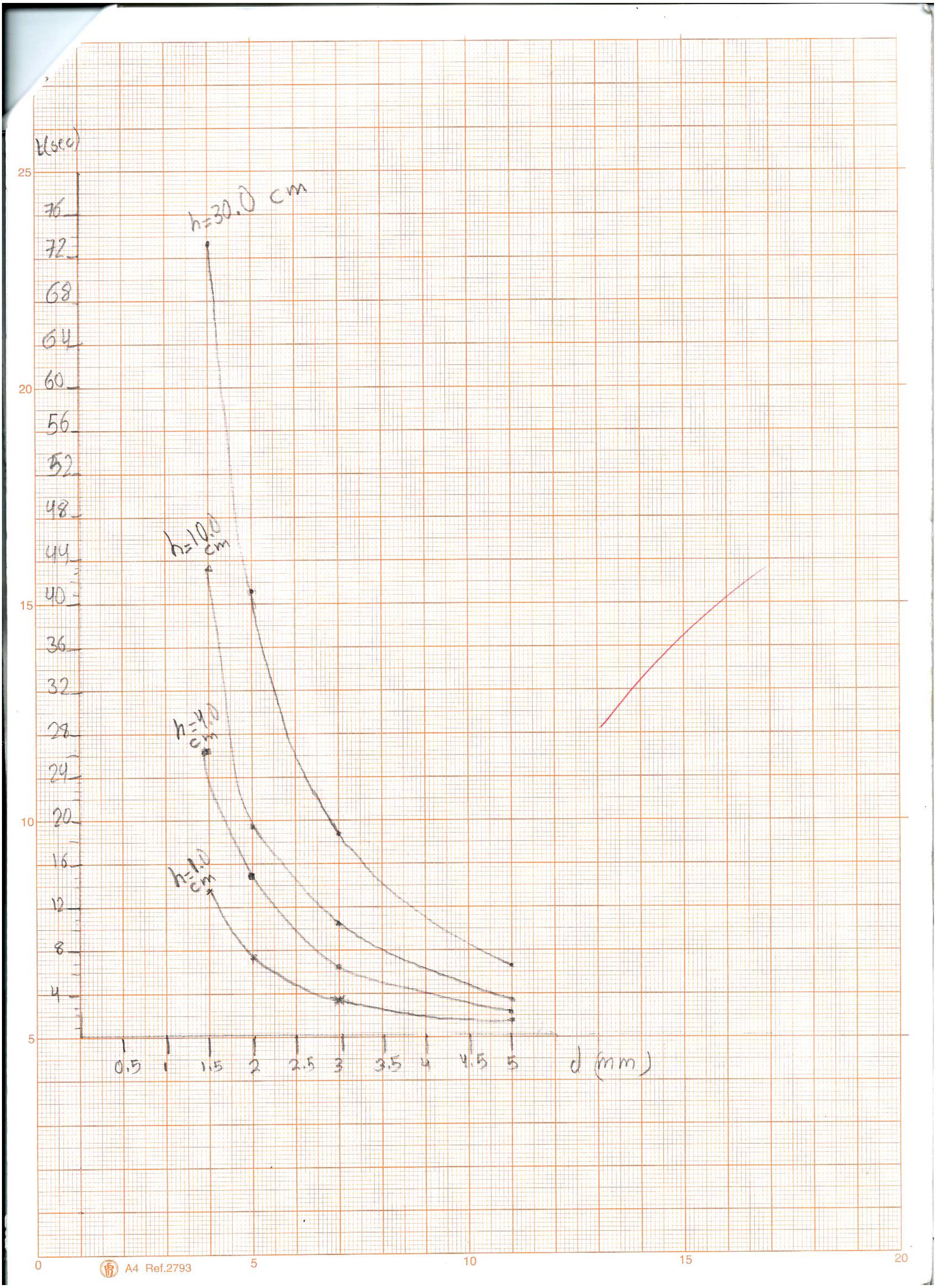
6. Can you predict the time needed to empty the container if the depth of water was **25 cm, 80 cm?**

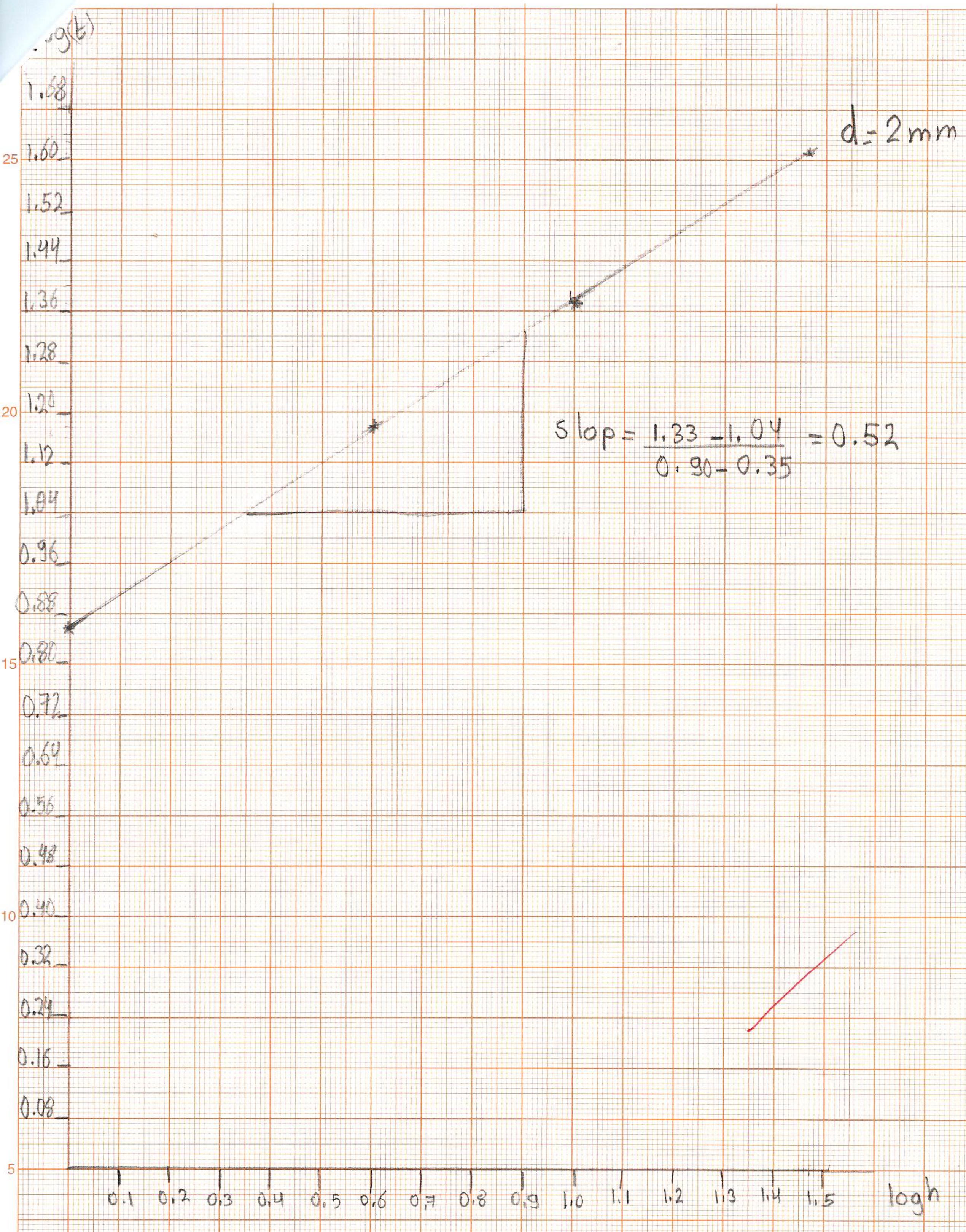
When $h = 25$ cm $\rightarrow$ $t = \sqrt{25}\ 10^{0.85}$ $\Rightarrow$ $t = 35.3$ sec.

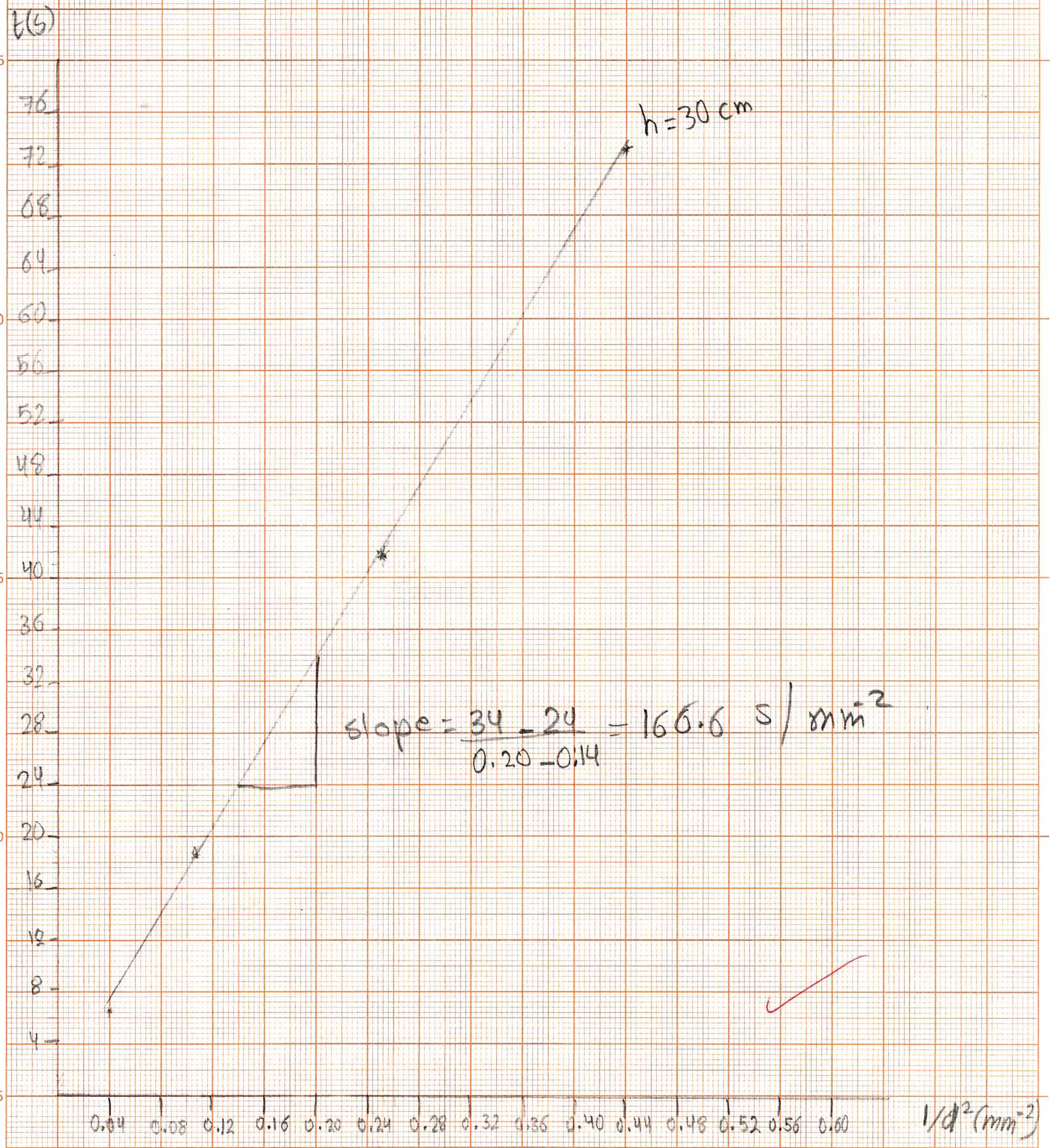
When $h = 80$ cm $\rightarrow$ $t = \sqrt{80}\ 10^{0.85}$ $\Rightarrow$ $t = 63.3$ sec.



t(sec)
h(mm)
d1= 1.5 mm
d2=2.0 mm
d3=3.0 mm
d4=5.0 mm
A4 Ref.2793


t(sec)
h=30.0 cm
h=10.0 cm
h=4.0 cm
h=1.0 cm
76
72
68
64
60
56
52
48
44
40
36
32
28
24
20
16
12
8
4
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
d (mm)
A4 Ref.2793


log(t)
d=2mm
slop = $\frac{1.33-1.04}{0.90-0.35}$ = 0.52
log h
1.68
1.60
1.52
1.44
1.36
1.28
1.20
1.12
1.04
0.96
0.88
0.80
0.72
0.64
0.56
0.48
0.40
0.32
0.24
0.16
0.08
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5



t(s)
h=30 cm
slope = 34 - 24 / 0.20 - 0.14 = 166.6 s/mm^2
1/d^2 (mm^-2)
4
8
12
16
20
24
28
32
36
40
44
48
52
56
60
64
68
72
76
0.04
0.08
0.12
0.16
0.20
0.24
0.28
0.32
0.36
0.40
0.44
0.48
0.52
0.56
0.60

A4 Ref.2793

* Experiment 2
Measurements and uncertainities

C → circumference محيط

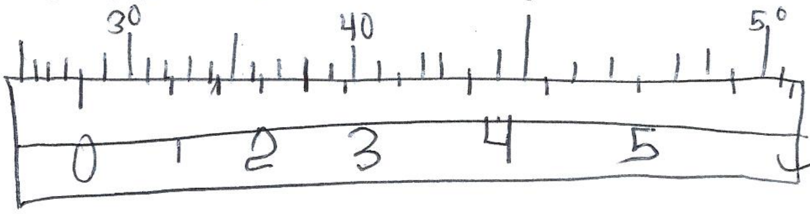
$\pi \rightarrow \frac{22}{7}$ / 3.14

d → diameter

$$\boxed{C = \pi d}$$

* vernier caliper

– we can measure d by vernier caliper



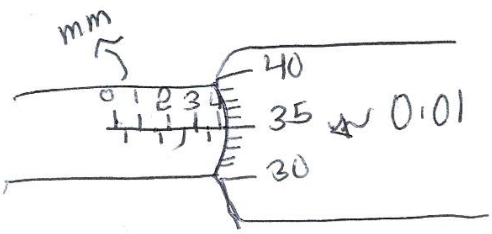
→ اقل تدريج 1 mm

→ اقل تدريج 0.05 mm

القراءة هنا هي 28.25 mm

error in vernier caliper $= \frac{1}{2} * 0.05 = 0.025$ mm

* micrometer



0.01 mm ← اقل تدريج

قراءة ال micrometer
4.35

error in micrometer
$\frac{1}{2} * 0.01 = 0.005$ mm

$\rho \rightarrow$ density الكثافة $\rho = \frac{m}{V} = \frac{\text{الكتلة}}{\text{الحجم}}$ (g/cm^3)

$V \rightarrow$ الحجم (volume) $V = \pi h (d/2)^2$

$$\rho = \frac{m}{\pi h (d/2)^2} = \boxed{\frac{4m}{\pi h d^2} \; g/cm^3}$$

$C = \pi d$

error in C

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

error in π

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

---

error in ρ $\rho = \frac{4m}{\pi h d^2}$

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

لا تنسى 2 في $\left(\frac{2\Delta d}{d}\right)^2$

To Know which error contributes most to π

$\Leftarrow$ نحسب $\frac{2\Delta d}{d}$ ونحسب $\frac{\Delta C}{C}$

والكمية الأكبر هي التي تؤثر اكبر على π

1

LAB REPORT FOR EXPERIMENT 2

Date: 10/10/2013

9

Name: زينة منصور

Partner's Name: عرينة

Registration No: 0133014

Registration No: 0130226

Physics Section: 17

Instructor's Name:

PHYSICS LAB EXPERIMENT 2 : MEASUREMENTS AND UNCERTAINTIES

I. PURPOSE :

1. make some elementary measurements of length and mass and derivee other quantities such as volume/density
2. estimate the uncertainty or the error in each measurement

II. DATA AND DATA ANALYSIS :

A. Measurement of π

Record your data in Table (2.1) below:

micrometer ~~vernier caliper~~

paper tape / meter stick

Table (2.1)

Trial No	d (cm)	$\lvert d-\bar{d}\rvert$ (cm)	c (cm)	$\lvert c-\bar{c}\rvert$ (cm)
1	3.95	2.7×10^{-6}	12.5	
2	3.96	8.1×10^{-5}		
3	3.945	3.6×10^{-5}		
4				
5				
Average	$\bar{d}$ = 3.951 cm		$\bar{c}$ = 12.5 cm	
Error	$\Delta\bar{d}$ = ± cm		$\Delta\bar{c}$ = ± 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 ($\Delta \bar{c}$):

$\Delta \bar{d} = \sqrt{\frac{1}{N(N-1)} \sum (d-\bar{d})^2}$ $\Delta \bar{d} = \sqrt{\frac{1}{3(3-1)} \times 1.995\times10^{-11}} = 4.46\times10^{-5}$ cm

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

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

$\bar{\pi} = \frac{\bar{c}}{\bar{d}}$ $\bar{\pi} = \frac{12.5}{3.951} = 3.1637$

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)**

$\Delta \bar{\pi} = 3.1637\sqrt{\left(\frac{4.46\times10^{-5}}{3.951}\right)^2 + \left(\frac{0.05}{12.5}\right)^2} = 0.01265$

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

$\frac{\Delta d}{\bar{d}} = 1.1288\times10^{-5}$ $\frac{\Delta c}{\bar{c}} = 4\times10^{-3}$

$\frac{\Delta c}{\bar{c}} > \frac{\Delta d}{\bar{d}} \Rightarrow \frac{\Delta c}{\bar{c}}$ is which contributes most

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

percentage error $= \frac{|\bar{\pi}_{exp} - \bar{\pi}_{acc}|}{\bar{\pi}_{acc}} \times 100\% = 0.586\%$

Determination of Density

Record your data in Table (2.2) below:

Table (2.2)

Trial No	h (cm)	$\lvert h-\bar{h}\rvert$(cm)	d (cm)	$\lvert d-\bar{d}\rvert$(cm)
1	8.95	0	0.440	2×10^{-3}
2			0.441	1×10^{-3}
3			0.445	3×10^{-3}
4				
5				
Average	$\bar{h}=$ 8.95 cm		$\bar{d}=$ 0.442 cm	
Error	$\Delta\bar{h}=\pm$ 0.005 cm		$\Delta\bar{d}=\pm$ 0.5 cm	
mass	$m=$ 9.31 g		$\Delta m=\pm$ 0.05 g	

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

$\Delta h = \frac{1}{2}\times 0.01$ mm

$= 0.005$

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

$\Delta d = \sqrt{\frac{1}{3(3-1)}\times 1.75} = \cancel{0.54}$ cm $\simeq 0.001$

error

3. Take Δm to be half the smallest division of the balance used .

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

$\bar{\rho} = \frac{4m}{\pi d^2 h} = \frac{4\times 9.31}{3.1637\times(0.442)^2\times 8.95} = \frac{4\times 9.31}{5.5317}$

-1

$= 6.732\,g/cm^3$

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

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

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

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

$\sqrt{\left(\frac{0.05}{9.31}\right)^2 + \left(\frac{0.025}{8.95}\right)^2 + \left(\frac{0.0126}{3.1637}\right)^2 + \left(2\frac{0.54}{0.492}\right)^2} = 0.0203.35\ g/cm^3$

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

$\frac{\Delta m}{m} = 2.8 \times 10^{-5}$ $\quad \frac{\Delta h}{h} = 7.8 \times 10^{-6}$

$\frac{\Delta\pi}{\pi} = 3.98 \times 10^{-3}$ $\quad \frac{2\Delta d}{d} = 5.97 \quad = 4.52 \times 10^{-3}$

$\frac{2\Delta d}{d} > \frac{\Delta\pi}{\pi}, \frac{\Delta m}{m}, \frac{\Delta h}{h} \Rightarrow \frac{2\Delta d}{d}$ contributes most

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

$\frac{\Delta h}{h} < \frac{2\Delta d}{d}, \frac{\Delta m}{m}, \frac{\Delta\pi}{\pi} \Rightarrow \frac{\Delta h}{h}$ contributes the least

8. Compare the measured value of $\bar{\rho} \pm \Delta\bar{\rho}$ with the accepted value of ρ. $\rho_{acc} = 8.3\ g/cm^3$

percentage error $= \frac{|\rho_{exp} - \rho_{acc}|}{\rho_{acc}} \times 100\%$

$= \frac{|6.732 - 8.3|}{8.3} \times 100\% = 18.8\%$

* Experiment 3

Force Table (Vectors)

Quantities
- scalar → Temperature/speed/volume/density/mass
- vector → velocity/acceleration/force/displacement

→ scalar quatities (algebrically) يجمعوا جبرياً

→ vector quantities
- Graphical method (polygon method) ⇓ (head-to-tail)
- method of components ↓

Graphical method:

mag = Length * choosen scale factor

direction → θ باستخدام المنقلة

$\Big\}\ \vec{R}$

Method of components:

$$\vec{R} = A_x\hat{i} + A_y\hat{j} + A_z\hat{k}$$

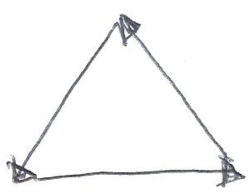
$$|\vec{R}| = \sqrt{(A_x)^2 + (A_y)^2 + (A_z)^2}$$

$$\theta = \tan^{-1}\left(\frac{A_y}{A_x}\right)$$

$$A_x = |A| \cos\theta$$

$$A_y = |A| \sin\theta$$

gwt ⇐ the resultant $\vec{R}$ وحدة



$\vec{R}$ resultant = 0

(begin and end in the same point)

OR by experiment (Foce table)

$\vec{R}_{equilibruim}$ = ________ $|\vec{R}|$ = ________

$\theta_{equilibruim}$ = ________ θ_R = ________

$\Rightarrow$ major sources of inaccuracy in experimental resultss

1- frictional force between pulleys

2- the angle not accurate

3- the force table is not horizontally.

10

LAB REPORT FOR EXPERIMENT 3

Date: 31/10/2013

Name: Zeina Mansour — Partner's Name: Areen

Registration No: 0133014 — Registration No: 0130226

Physics Section: 17 — Instructor's Name: Wafaa'

PHYSICS LAB EXPERIMENT 3: VECTORS (FORCE TABLE)

I. PURPOSE :

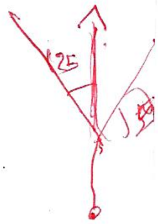
To calculate the magnitude and direction of the resultant force by force table, graphically, components

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) .

θ balance $= 253^\circ$ | $\theta_R = 253 - 180 = 73^\circ$

$\vec{R} = 130$ gwt | $|\vec{R}| = 130$ gwt



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

$\vec{R} = 12.5 \times 10 - 125$ gwt

$\theta_R = 73.5^\circ$

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?

$\vec{F}_1 = 100 \cos 35 \hat{i} + 100 \sin 35 \hat{j} = 81.9 \hat{i} + 57.3 \hat{j}$

$\vec{F}_2 = 80 \cos 125 \hat{i} + 80 \sin 125 \hat{j} = -45.8 \hat{i} + 65.5 \hat{j}$

$\vec{R} = 36.1 \hat{i} + 122.8 \hat{j}$

$|\vec{R}| = \sqrt{(36.1)^2 + (122.8)^2} = 128$ gwt

$\theta = \tan^{-1}\left(\frac{122.8}{36.1}\right) = 73^\circ$

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

θ balanced = 147 | $\theta_R = 147 + 180 = 327$

$\vec{R} = 200$ gwt | $|\vec{R}| = 200$ gwt

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.

$\vec{R} = 9.2 \times 20 = 194$ gwt

$\theta_R = 330$

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.

$\vec{R}_x = 100 \cos 315 + 200 \cos 30 + 150 \cos 240 = 168.91$

$\vec{R}_y = 100 \sin 315 + 200 \sin 30 + 150 \sin 240 = -100.61$

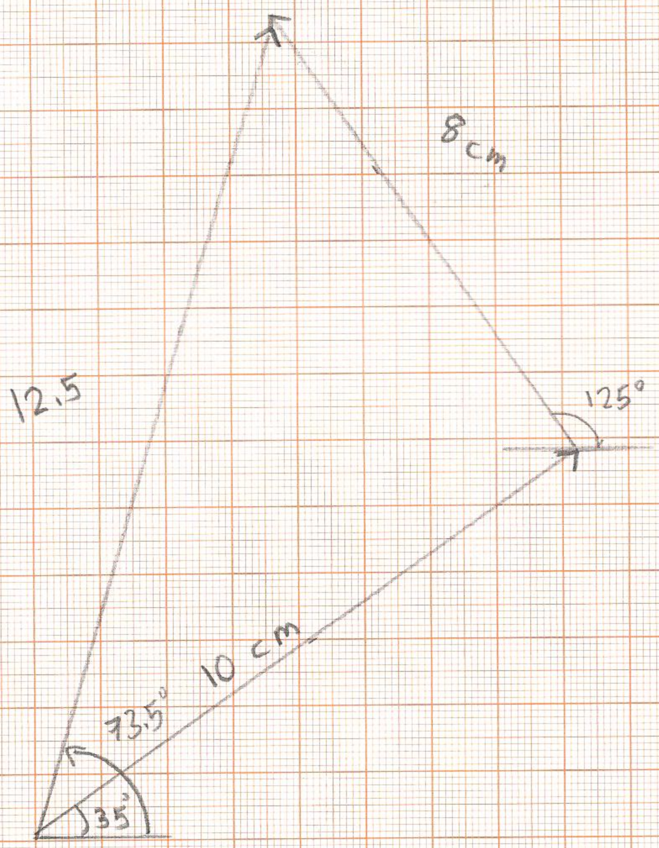
$\vec{R} = 168.91\hat{i} - 100.61\hat{j}$

$|\vec{R}| = \sqrt{(168.91)^2 + (-100.61)^2} = 196$ gwt

$\theta = \tan^{-1}\left(\frac{-100.61}{168.91}\right) = -30.7$

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

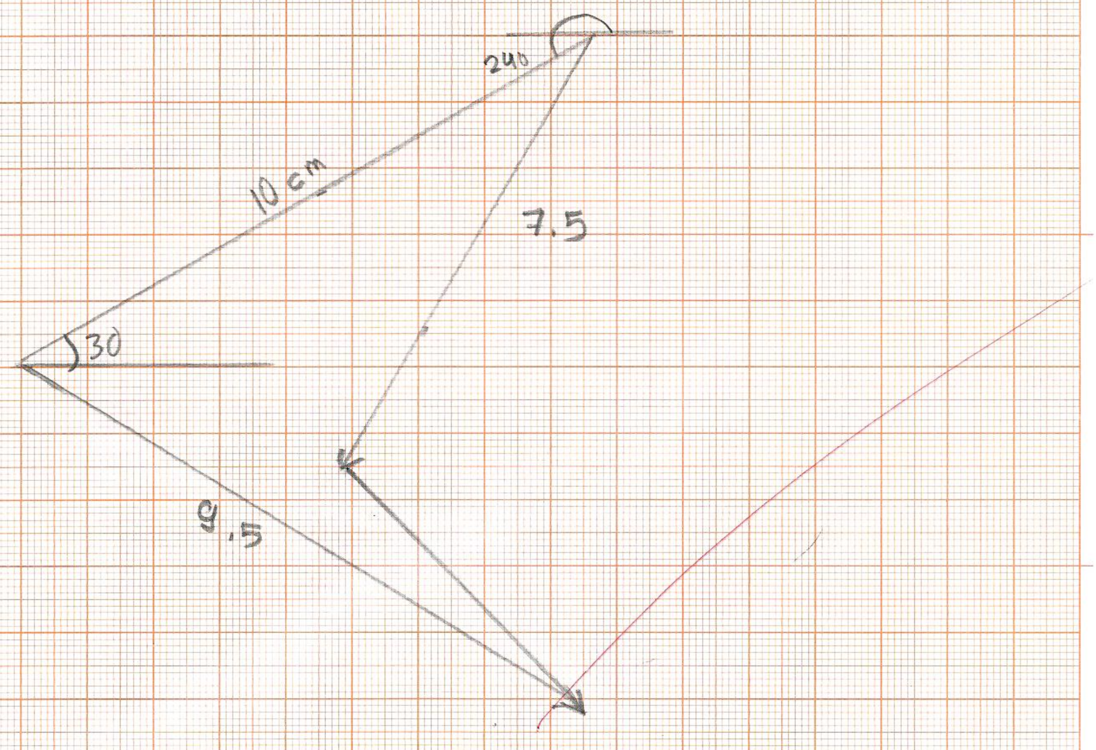
1. The frictional force between pulleys
2- The force table is not horizontally
3- The angle not accurate



$\vec{R} = 12.5 \times 10 = 125$ gwt

$\theta = 73.5°$

10 g → 1 cm
100 g → 10 cm



200 g → 10 cm

20 g → 1 cm

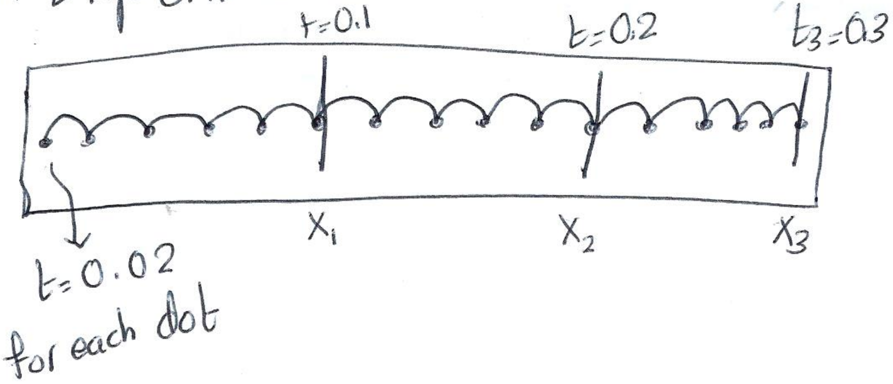
100 g → 5 cm

150 g → 7.5

R = 9.5 × 20 = 194 gwt

θ_R = 330°

* Experimental 4 (Kinematics of rectilinear motion)



- acceleration (m/s^2)

- When the spaces between the dots become larger the speed is highest and when it is smaller the speed is lowest

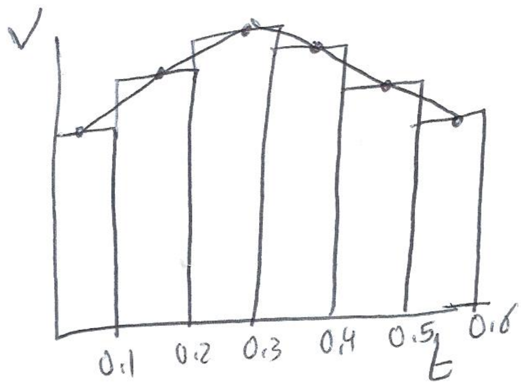
$\vec{V}_{2-10} = \boxed{}$ $\vec{V}_{3-9} = \boxed{}$ $\vec{V}_{4-8} = \boxed{}$

$\vec{V}_{5-7} = \boxed{}$ find $\vec{v}_{ins}$ at $t_6 = 0.6$

↓

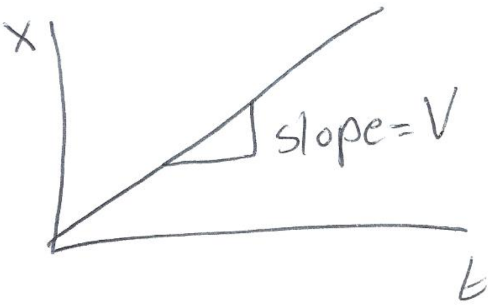
the shorter the time interval is with the same mid point the more accurate it is $\longrightarrow \vec{V}_{5-7} = V\big|_{t_6=0.6}$

- $\vec{V}_{avg}$ of the interval = $\vec{v}_{ins}$ at the mid of the interval
- velocity is constant during the interval so $\vec{a}$ = Zero at any time in the interval



area = distance moved

histogram



$\Rightarrow$ slope of the tangent line at $t=a$ $\equiv$ V ins at $t=a$

/

LAB REPORT FOR EXPERIMENT 4

Date: 24/10/2013

Name: Zeina Mansour

Partner's Name: Areen

Registration No: 0133014

Registration No: 0130226

Physics Section: 17

Instructor's Name: Wafaa

PHYSICS LAB EXPERIMENT 4: KINEMATICS OF RECTILINEAR MOTION

I. PURPOSE :

The purpose is to study of the Kinematics of motion of an object by record the object's position at different times (study irregular motion (made by hand))

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				
0.05		0.8-0=0.8	$\frac{0.8}{0.1} = 8$		
0.1	0.8			12-8=4	$\frac{4}{0.1} = 40$
0.15		2-0.8=1.2	$\frac{1.2}{0.1} = 12$		
0.2	2			17-12=5	$\frac{5}{0.1} = 50$
0.25		3.7-2=1.7	$\frac{1.7}{0.1} = 17$		
0.3	3.7			10-17=-7	$\frac{-7}{0.1} = -70$
0.35		4.7-3.7=1	$\frac{1}{0.1} = 10$		
0.4	4.7			11-10=1	$\frac{1}{0.1} = 10$
0.45		5.8-4.7=1.1	$\frac{1.1}{0.1} = 11$		
0.5	5.8			17-11=6	$\frac{6}{0.1} = 60$
0.55		7.5-5.8=1.7	$\frac{1.7}{0.1} = 17$		
0.6	7.5			18-17=1	$\frac{1}{0.1} = 10$
0.65		9.3-7.5=1.8	$\frac{1.8}{0.1} = 18$		
0.7	9.3			20-18=2	$\frac{2}{0.1} = 20$
0.75		11.3-9.3=2	$\frac{2}{0.1} = 20$		
0.8	11.3			19-20=-1	$\frac{-1}{0.1} = -10$
0.85		13.2-11.3=1.9	$\frac{1.9}{0.1} = 19$		
0.9	13.2			20-19=1	$\frac{1}{0.1} = 10$
0.95		15.2-13.2=2	$\frac{2}{0.1} = 20$		
1.0	15.2				

Avg speed $= \vec{v}_i = \frac{\Delta x_i}{\Delta t} \Rightarrow$ cm/s

$\Delta t \Rightarrow 0.1$ s

Avg acc. $= \vec{a}_i = \frac{\Delta v_i}{\Delta t} \Rightarrow$ cm/s^2

$\Delta t \Rightarrow 0.1$ s

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

Table (4.2)

Total Time t_i (s)	Distance on Tape x_i (cm)	Average Speed $\bar{v}$ (cm/s)	
$t_2 = 0.2$	$x_2 = 2$	$\bar{v}_{2\text{-}10} = \frac{x_{10}-x_2}{t_{10}-t_2} = \frac{15.2-2}{1-0.2} =$	16.5
$t_3 = 0.3$	$x_3 = 3.7$		
$t_4 = 0.4$	$x_4 = 4.7$	$\bar{v}_{3\text{-}9} = \frac{x_9-x_3}{t_9-t_3} = \frac{13.2-3.7}{0.9-0.3}$	= 15.8
$t_5 = 0.5$	$x_5 = 5.8$		
$t_6 = 0.6 = t_m$	$x_6 = 7.5$	$\bar{v}_{4\text{-}8} = \frac{x_8-x_4}{t_8-t_4} = \frac{11.3-4.7}{0.8-0.4}$	= 16.5
$t_7 = 0.7$	$x_7 = 9.3$		
$t_8 = 0.8$	$x_8 = 11.3$	$\bar{v}_{5\text{-}7} = \frac{x_7-x_5}{t_7-t_5} = \frac{9.3-5.8}{0.7-0.5}$	= 17.5
$t_9 = 0.9$	$x_9 = 13.2$		
$t_{10} = 1.0$	$x_{10} = 15.2$		

the shorter the time interval is with the same mid point the more accurate it is

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?

____

____

____

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 ?

___

___

___

2. Plot a **histogram** of average speed $\bar{\mathbf{v}}$ against time **t.** Fig.4.2 shows a histogram of the data in the sample table.
   Can you see regions where v is increansing? Decreasing? Constant?

___

___

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? Can you tell what is the instantaneous speed at the midpoint $\mathbf{t_6 = 0.6}$ **s** ?

2

$V_{ins} = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = 17.5$ cm/s ✓

4. On your histogram of $\bar{\mathbf{v}}$ 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?

1. V_{avg} of the interval = V_{ins} at the half of the interval
2. velocity is constant in the interval so the acceleration is zero at any time in the interval ✓

5. From your **(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. ?

it is agree with B-3 and it is (17.5 cm/s) and it is also agree with the information in table 4.2)

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** ?

yes it is the same and equal to ~~4.7 cm/s~~

16.6

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 ?

area = 8 x 0.1 + 12 x 0.1 + 17 x 0.1 + 10 x 0.1 = 0.8 + 1.2 + 1.7 + 1 = 4.7 cm

it represent the distance moved

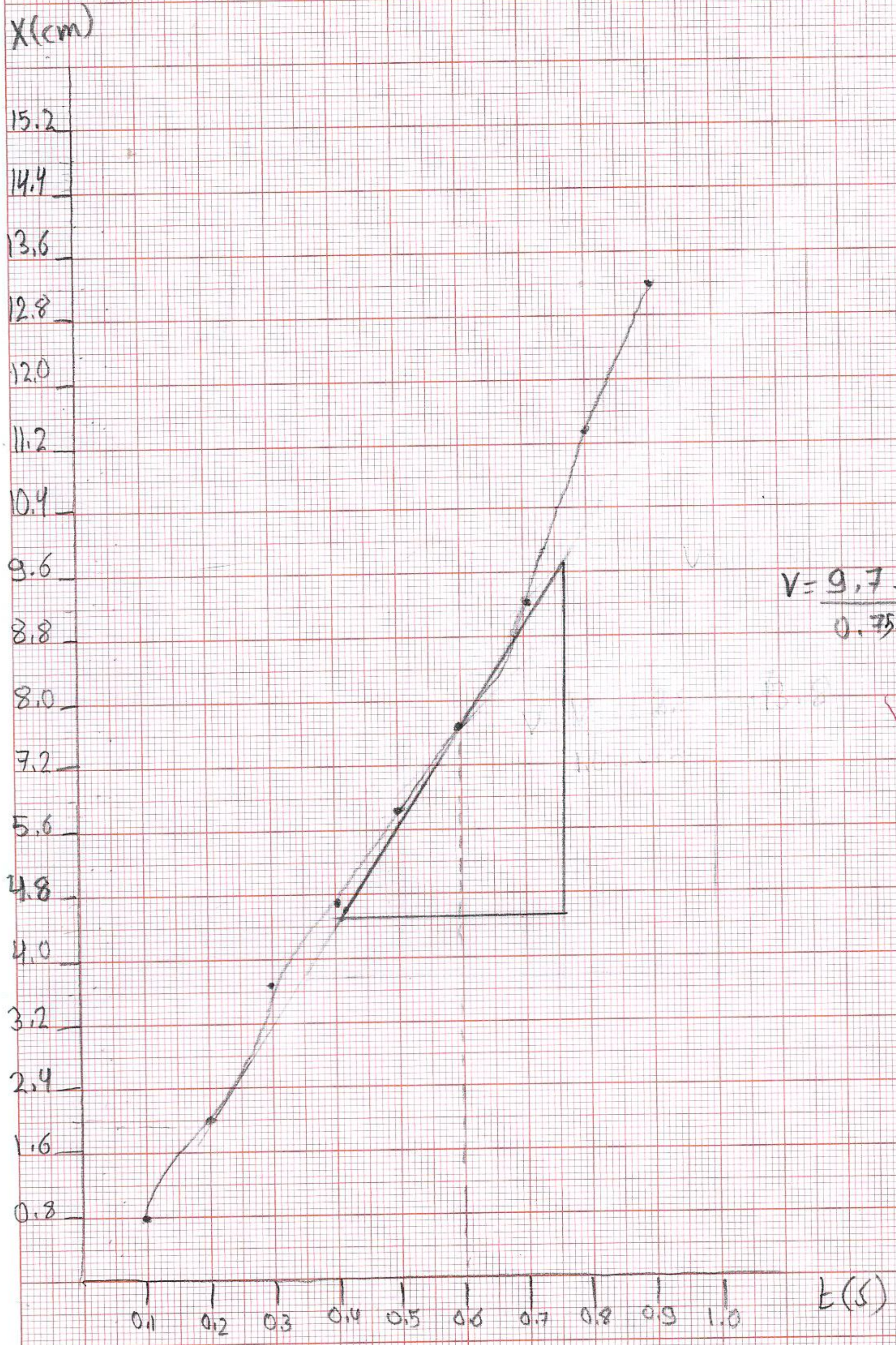
8. Now measure directly on the **paper strip** the distance actually moved during the time interval from t_i to t_f. Compare with the answer you got in B-7.

The distance moved is 4.7 cm from the paper strip which is the same result B-7

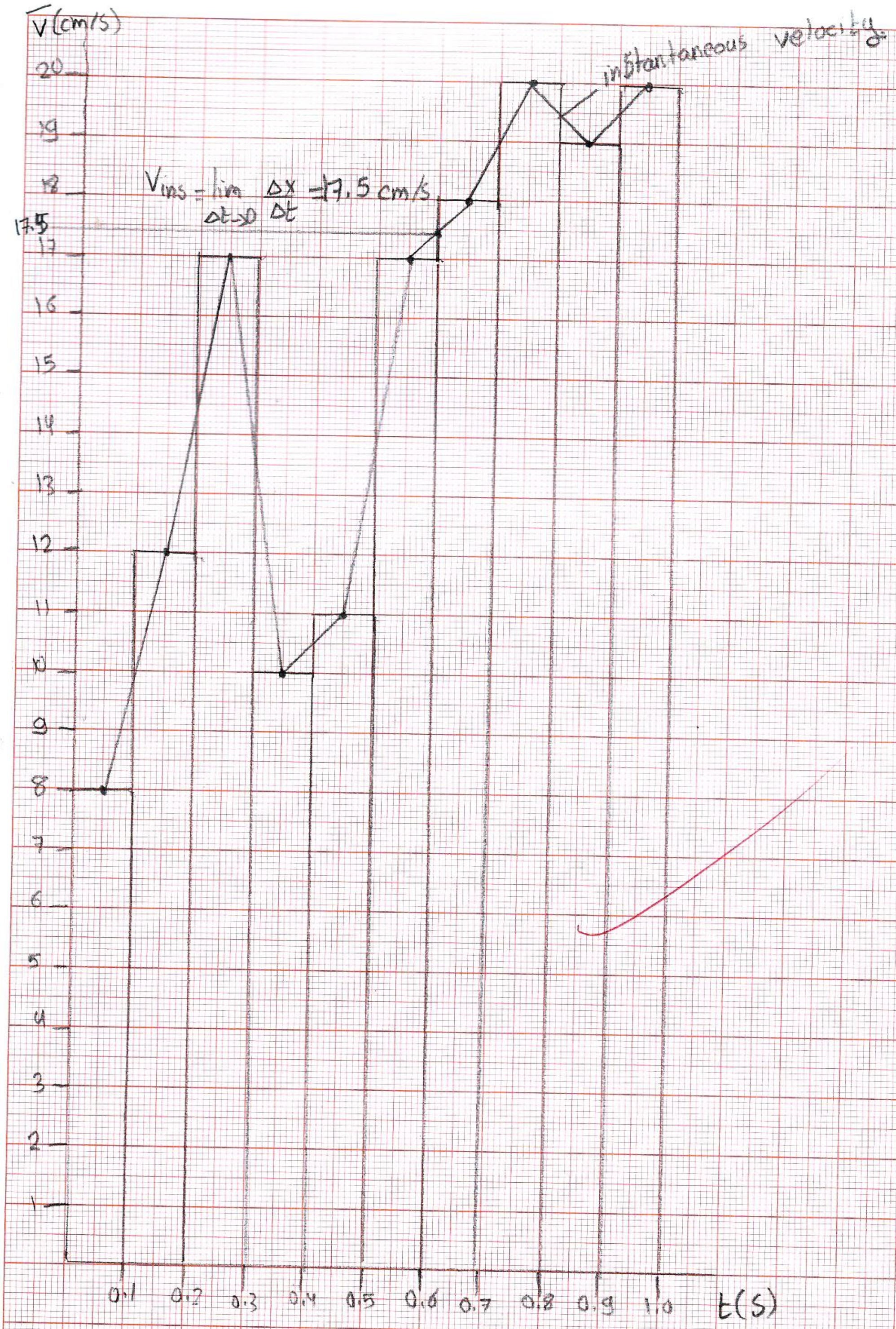
9. Using your computed data of the average acceleration $\bar{a}$ in Table (4.1) plot a smooth graph of instantaneous acceleration **(a)** against the time **t**. How good was your early guess as to the times of the greatest and the smallest accelerations?

the greatest acceleration (70 cm/s²)

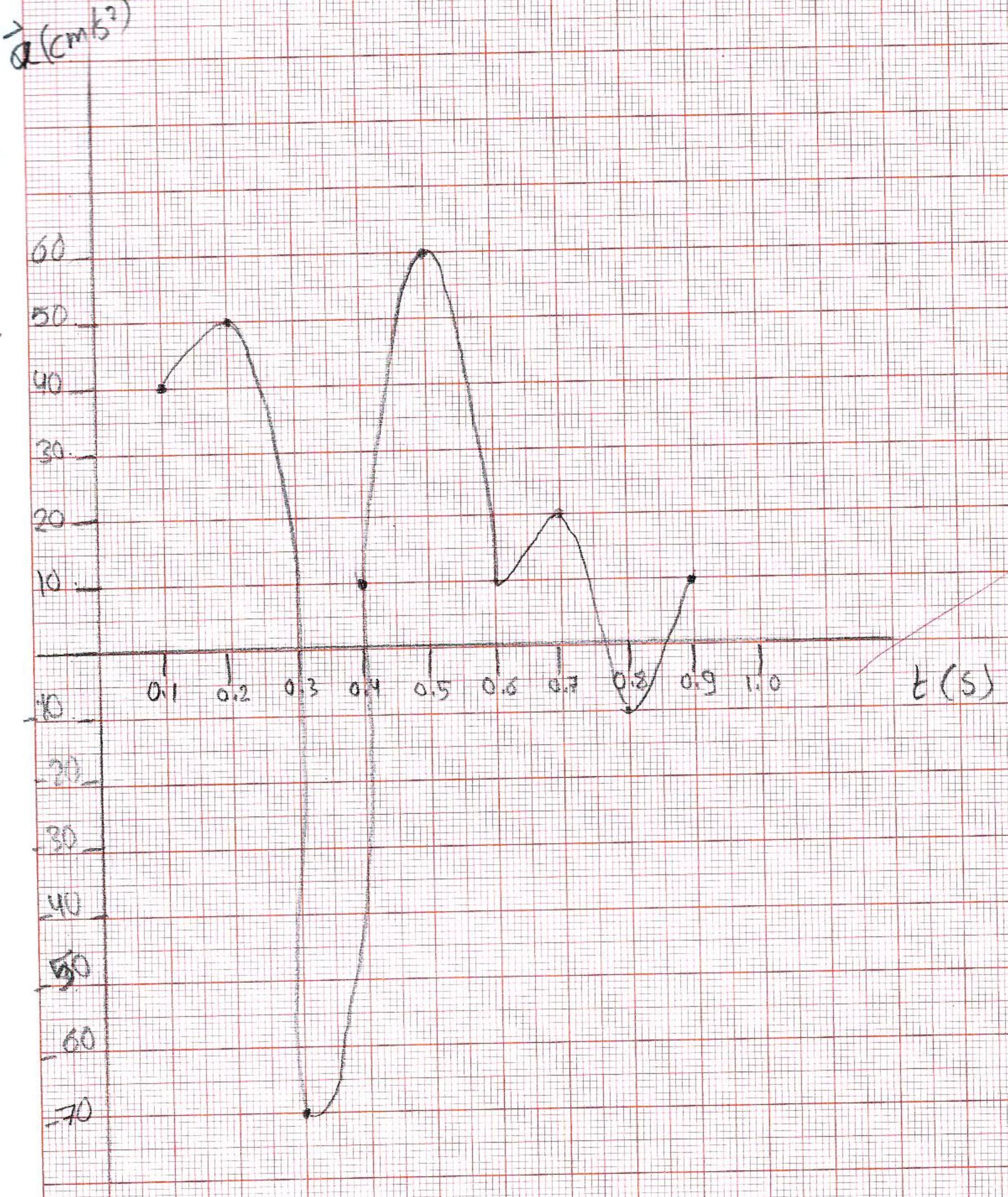
the smallest acceleration (0 cm/s²)



$$V = \frac{9.7 - 4.7}{0.75 - 0.4} = 16.6$$



$\bar{v}$ (cm/s)
20
19
18
17.5
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
$V_{ins} = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = 17.5$ cm/s
instantaneous velocity
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
t(s)

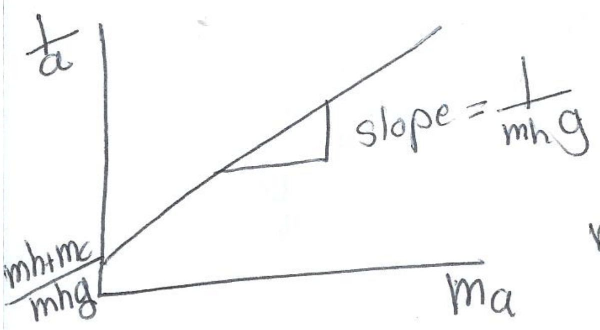


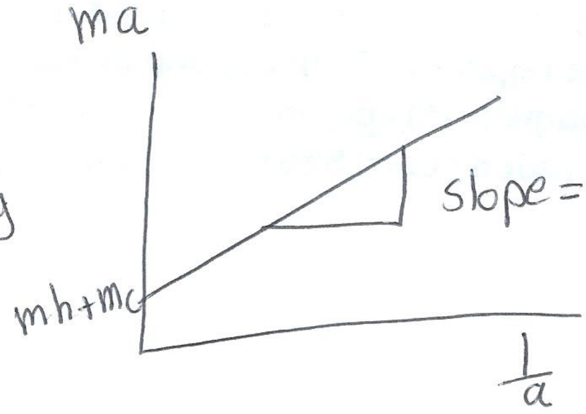
$\vec{a}$ (cm/s²)
60
50
40
30
20
10
-10
-20
-30
-40
-50
-60
-70
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
t (s)

* Experiment 5 (Force and motion)

$m_a \rightarrow$ variable / $a \rightarrow$ variable

1 constant force

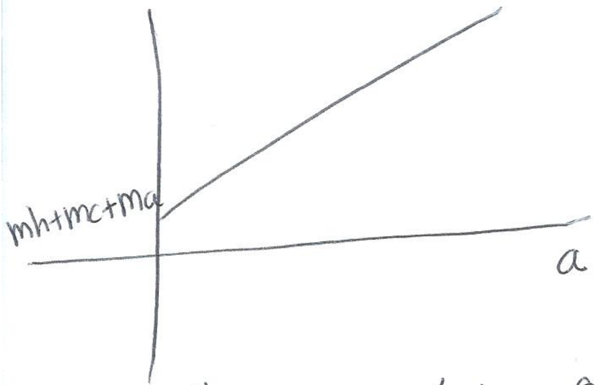




كلما زادت m_a قل التسارع acceleration

كلما زادت m_h زاد التسارع acceleration

2 constant total mass / $m_h \rightarrow$ variable



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

$$T = a(m_c + m_a)$$

$$m_h g - T = m_h a$$

* نأخذ السطح المائل بزاوية θ فتكون هذه الزاوية θ هي ما يجعل مركبات القوى من غير احتكاك

ok

9.5

LAB REPORT FOR EXPERIMENT 5

Date: 21/11/2013

Name: Zeina Mansour — **Partner's Name:** Areen

Registration No: 0133014 — **Registration No:**

Physics Section: 17 — **Instructor's Name:**

* نأخذ السطح مائل بزاوية θ فتكون هذه الزاوية θ هي ما يحصل مركبات للقوى من غير احتكاك

PHYSICS LAB EXPERIMENT 5: FORCE AND MOTION

I. PURPOSE:

To investigate how different forces accelerate a given mass and how a given force accelerates different masses, and a force changes a state of object from rest to movement

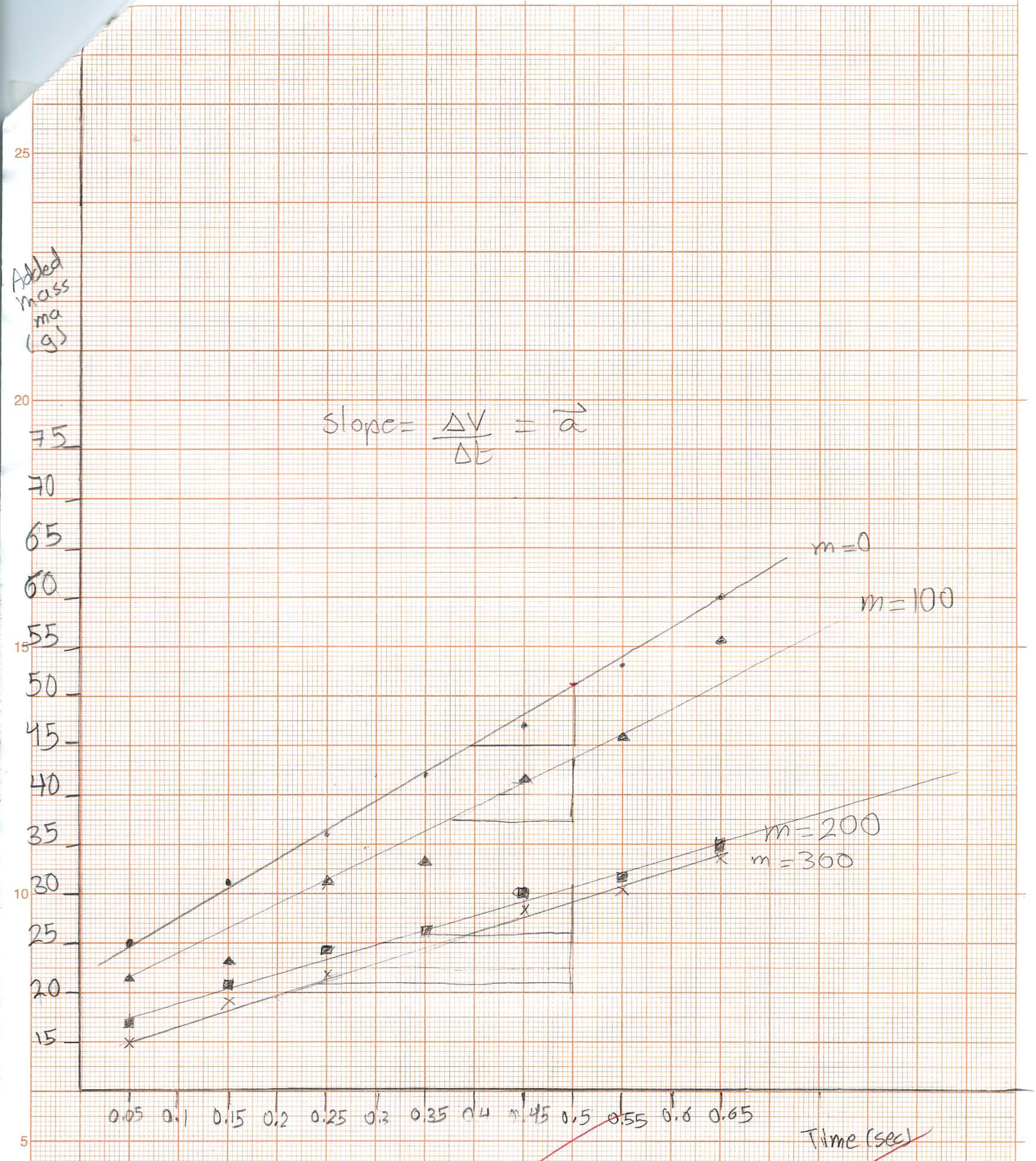
II. DATA AND DATA ANALYSIS

A. Acceleration and Added Mass with Constant Driving Force

1-Enter your computed values of v versus t in Table (5.1) below:

Table (5.1)

Added mass m_a (g)	Time t (s)	0.05	0.15	0.25	0.35	0.45	0.55	0.65
m = 0	v(cm/s)	25	31	36	42	47	53	60
m = 100	v(cm/s)	22	23	32	33	42	46	52
m = 200	v(cm/s)	17	21	24	26	30	32	35
m = 300	v(cm/s)	15	19	22	25	29	31	34
m = 400	v(cm/s)							



slope for $ma_{0g} = \frac{\Delta V}{\Delta t} = \frac{51-45}{0.5-0.39} = 54.5$ cm/s²

slope for $ma_{200g} = \frac{\Delta V}{\Delta t} = \frac{31-25}{0.5-0.35} = 37.5$ cm/s²

slope for $ma_{100g} = \frac{\Delta V}{\Delta t} = \frac{43-40}{0.5-0.42} = 44$ cm/s²

slope for $ma_{300g} = \frac{\Delta V}{\Delta t} = \frac{31-20}{0.5-0.21} = 33$ cm/s²

A4 Ref.2793

2- For **each** value of 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.

3- What conclusions do you draw from your graphs about the acceleration of the empty and loaded cart under a constant applied force?

The acceleration of the cart decreases due to mass because

$m \propto \frac{1}{a}$ $\quad F = ma \quad a = \frac{F}{m}$

$m = \frac{F}{a}$ (inverse relation)

4- **Calculate the slope of each graph and determine the acceleration (a) in each case,** and enter your calculated values in Table (5.2) below:

Table (5.2)

Added mass m_a (g)	Acceleration a (cm/s²)	1/a (s²/cm)
0	54.5	0.018
100	44	0.022
200	37.5	0.026
300	33	0.030
400		

5- **Plot a** graph of **added mass to cart m_a** versus **1/a.**. From the graph what conclusion can you make about the way the acceleration of the cart depends on its total mass?

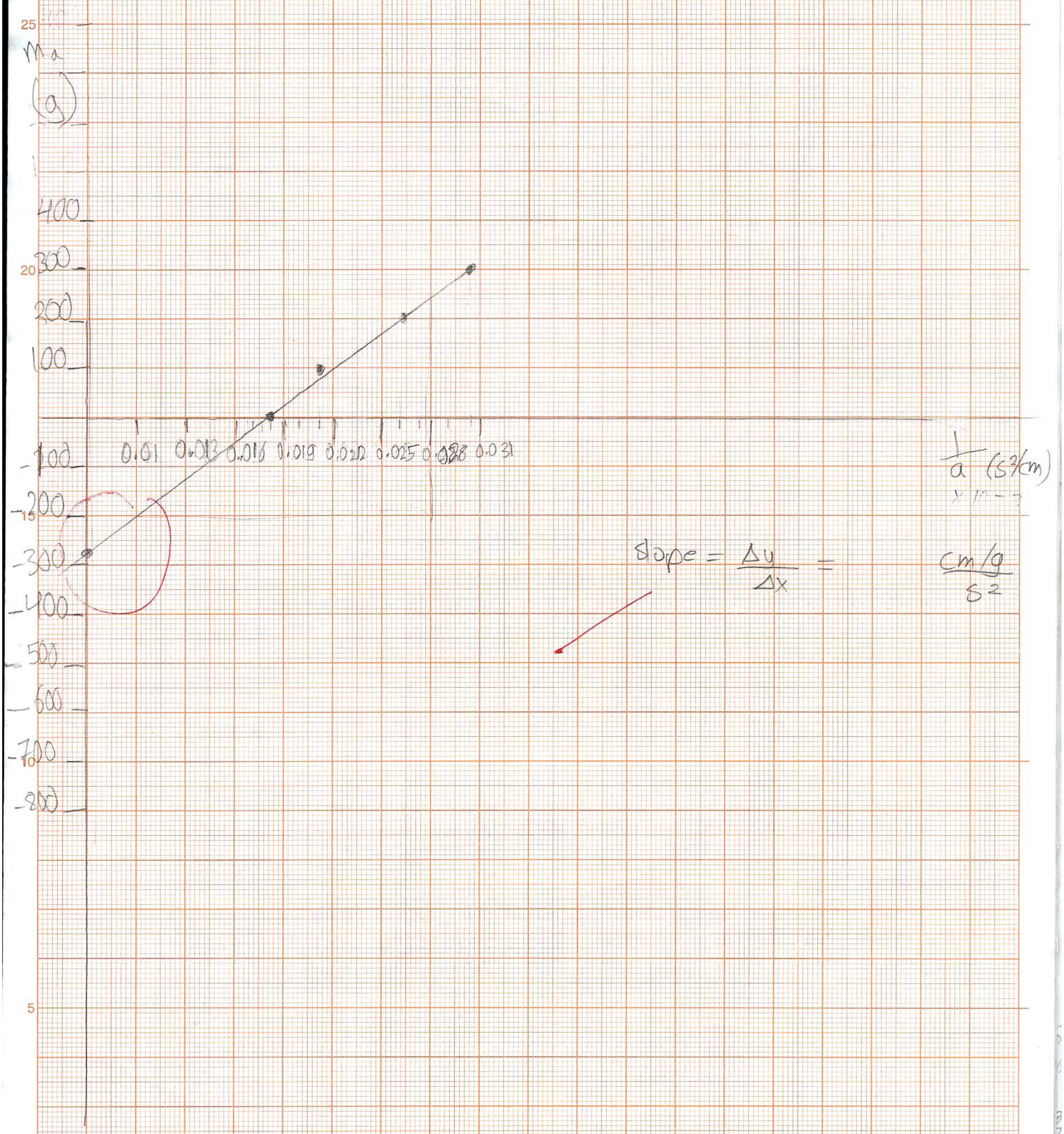
The acceleration is inversaly propotional to its total mass (it decrease with increasing mass)

4 $\quad$ -5

6- From your graph, find the mass m_c of the cart alone .

The intercept (b) = $(m_c + m_h)$ $\quad -290 = -(m_c + m_h)$

$m_c = 290 - 50$ g $= 240$ g ???



slope = $\frac{\Delta y}{\Delta x}$ = $\frac{cm/g}{s^2}$

A4 Ref.2793

B. Acceleration and Driving Force with Constant Mass of Accelerating System

1. As in the analysis of **part A** compute the velocity v for each recorded tape, and enter your data in Table (5.3) below:

Table (5.3)

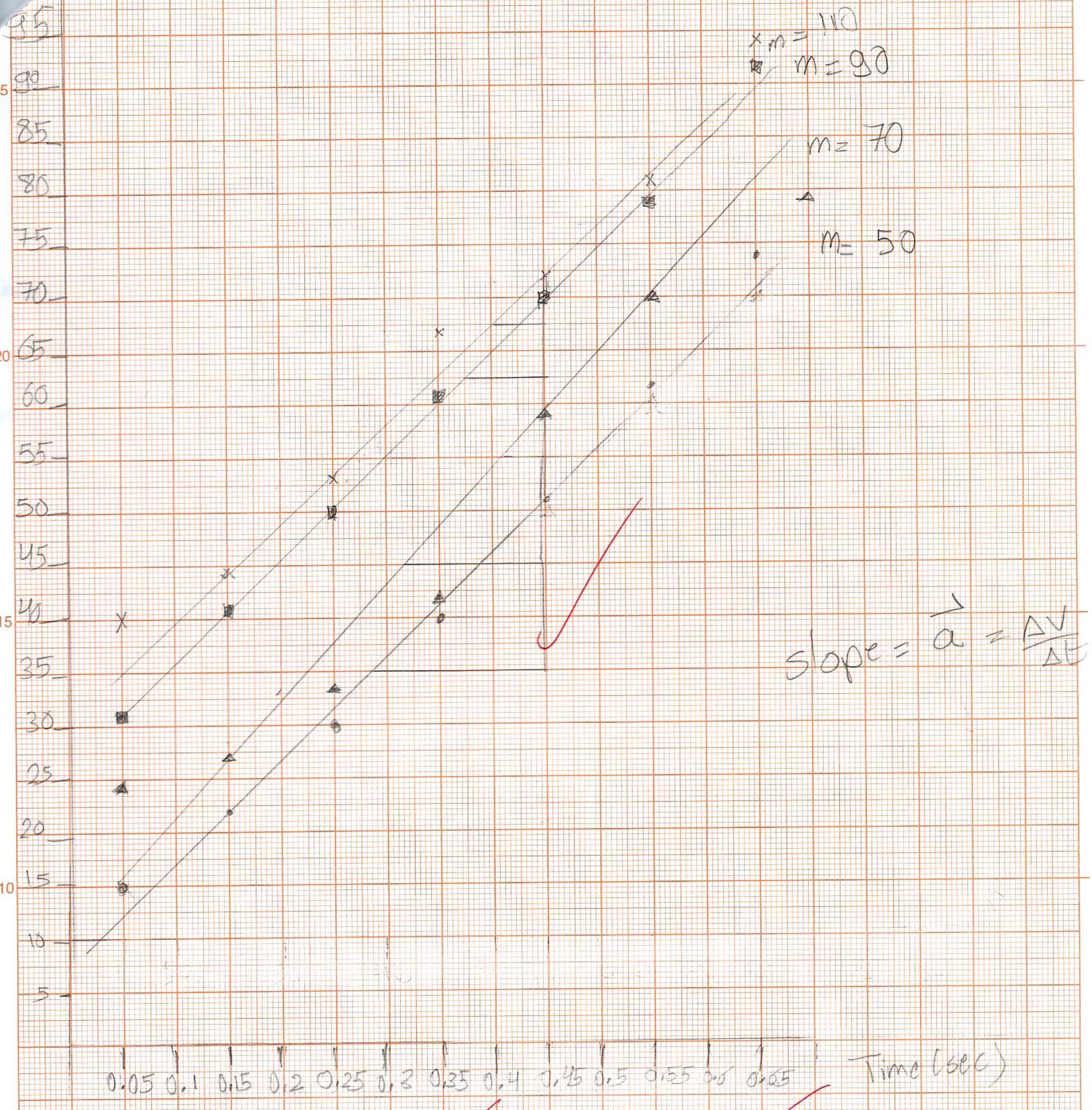
Total hanging mass m_h (g)	Time t (s)	0.05	0.15	0.25	0.35	0.45	0.55	0.65
50 added ~~20~~	v(cm/s)	15	22	30	40	51	62	74
70 ~~40~~	v(cm/s)	29	27	33	41	59	70	79
90 ~~60~~	v(cm/s)	31	41	50	61	70	79	92
110 ~~80~~	v(cm/s)	40	44	53	67	72	81	99
130 100	v(cm/s)							

2. Use your table to plot, **on the same sheet of paper**, graphs of **v** against **t**, for each value of the total hanging mass. What do you conclude from your graphs?

increasing the mass (hanging mass) it will increase
the acceleration (direct relation)

3. Determine the acceleration (a) of the system in each case by calculating the slopes.

4. Enter your data for hanging weight (m_h g) [where (g), the acceleration due to gravity is 980 cm/sec^2] and corresponding acceleration in Table 5.4 below:



slope for m_h = 120 cm/s^2
50g

slope for m_h = 90 cm/s^2
90g

slope for m_h = 100 cm/s^2
70g

slope for m_h = 77 cm/s^2
110g

A4 Ref.2793

Table 5.4

Hanging weight $m_h g$ (dyne)	Acceleration a (cm/s^2)
$50 \times 980 = 49000$	77 cm/s^2
$70 \times 980 = 68600$	90 cm/s^2
$90 \times 980 = 88200$	100 cm/s^2
$110 \times 980 = 107800$	1~~1~~5 cm/s^2
$130 \times 980 = 127400$	

5. Plot a graph of the **hanging weight (m_h g) against** the corresponding **acceleration (a)**.

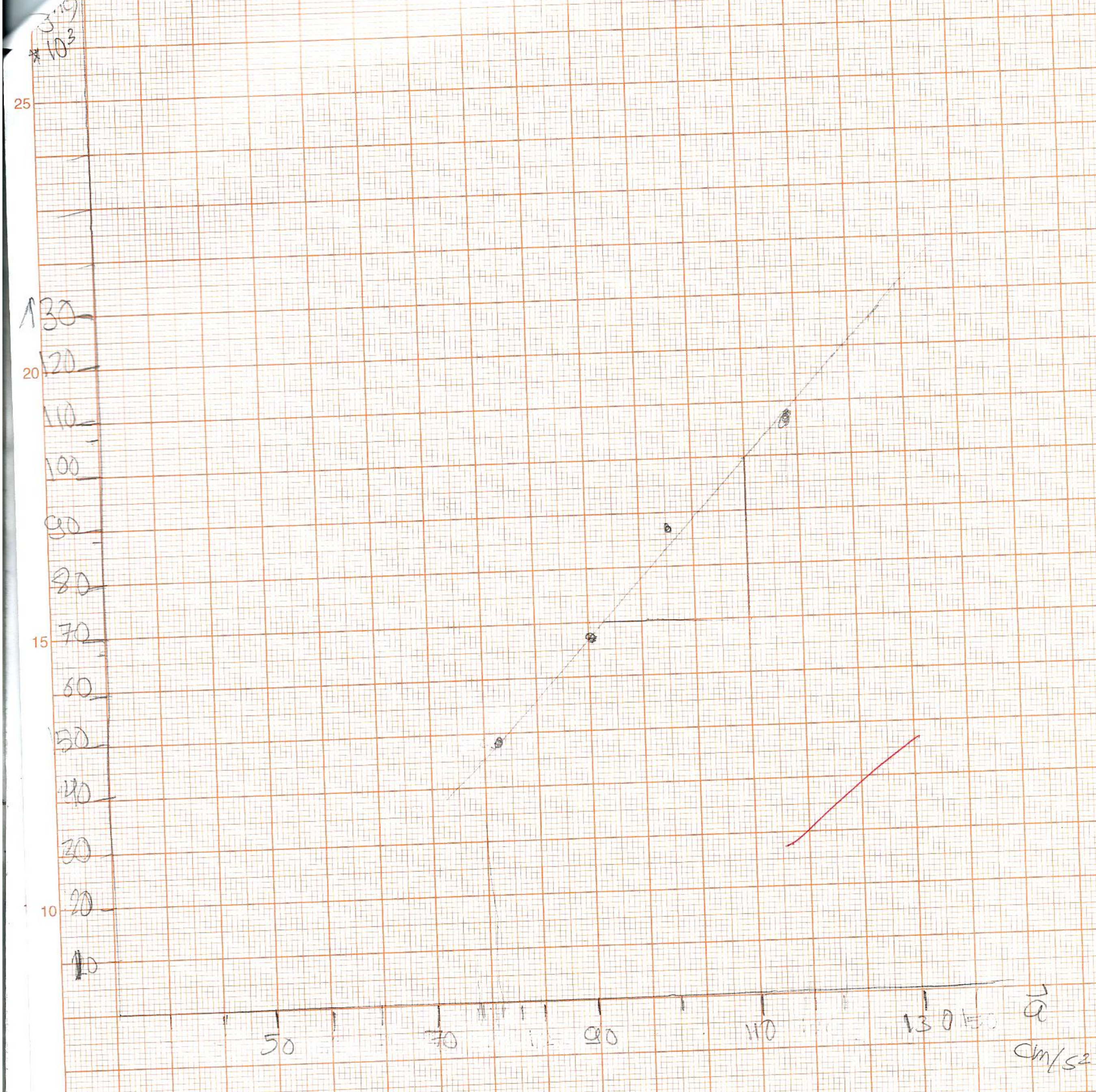
6. Calculate the slope of your graph.

slope $= \frac{\Delta y}{\Delta x} = 16.66 \times 10^2 \ \frac{dyne \cdot s^2}{cm}$

7. What does the slope of your graph represent ? Does it pass through the origin? why? or why not? Explain.

It represent the total mass ($m_c + m_a + m_h$)

Yes in theorem, because when there is no force acts on the body the acceleration is zero



$$\text{Slope} = \frac{\Delta y}{\Delta x} = \frac{\text{dyne}}{\text{cm}/s^2} = \frac{\text{dyne}\cdot s^2}{\text{cm}}$$

$$= 1666 \ \frac{\text{dyne}\cdot s^2}{\text{cm}^2}$$

$$= 16{,}66 \times 10^2$$

Experiment 6 (collision in Two dimensions)

projectile sphere p (ball 1)

Target sphere T (ball 2)

* The momentum is propotional to the velocity because the initial velocity is horizontal

$$X + \theta = 90$$

$V_{2i} = 0$ elastic collision $m_1 = m_2$

$P_o P_{o_1}$ = momentum before collision for the projectile $\equiv V_{1i}$

$T_o T_1$ = momentum after collision for the Target

$P_o P_1$ = momentum after collision for the projectile

$\equiv V_{1f} + V_{2f}$

* momentum is conserved

$$\overrightarrow{P_o P_{o_1}} = \overrightarrow{P_o P_1} + \overrightarrow{T_o T_1}$$

$\Delta p =$

$\Delta \theta =$

* Kinetic energy is conserved

$$(P_o P_{o_1})^2 = (P_o P_1)^2 + (T_o T_1)^2$$

9

LAB REPORT FOR EXPERIMENT 6

Date: 28/11/2013

Name: Zeina Mansour **Partner's Name:** Areen

Registration No: 0133014 **Registration No:**

Physics Section: 17 **Instructor's Name:**

PHYSICS LAB EXPERIMENT 6 : COLLISION IN TWO DIMENSIONS

I. PURPOSE :

To study the way in which momentum is transferred between two spheres of equal mass, in a two-dimensional collision

II. ANALYSIS OF DATA AND CONCLUSIONS:

1. Since the masses of the spheres are equal, the velocity vectors can be used to represent the momenta of the spheres. Thus, the vector $\mathbf{P_0P_{01}}$ on the sheet represents the **momentum of the projectile sphere before collision,** measure the length $\mathbf{P_0P_{01}}$ and record it on your working sheet of paper.
The vectors $\mathbf{P_0P_1}$ and $\mathbf{T_0T_1}$ represent respectively the **momenta** of the **projectile** sphere and the **target** sphere **after collision,** measure $\mathbf{P_0P_1}$ and $\mathbf{T_0T_1}$ and record them on your working sheet of paper .

2. **Graphically add** the two momentum vectors $\mathbf{P_0P_1}$ and $\mathbf{T_0T_1}$ on your paper by placing the **tail** of the momentum vector of the target sphere at the **head** of the momentum vector of the projectile sphere.

3. How does the **vector sum** of the **final momenta** $\mathbf{P_0P_1}$ and $\mathbf{T_0T_1}$ of the two spheres **compare** with the **initial momentum** $\mathbf{P_0P_{01}}$? Estimate the error in your result.

بعد قبل

$\overrightarrow{P_0P_{01}} = \overrightarrow{T_0T_1} + \overrightarrow{P_0P_1} \rightarrow 44.3\,cm \approx 42.5\,cm$

-0.5

$\Delta p = 2.2\,cm$

$\Delta\theta = 3.5°$

4. Is momentum **conserved** in these interactions?

yes with experimental error

$44.3 \simeq 42.5$

5. In an elastic collision, the total kinetic energy (**½mv²**) is the **same** before and after the collision. Calculate the kinetic energy before and after the collision and compare the two values.

g cm/s

$(P_0P_{01})^2 = (T_0T_1)^2 + (P_1P_1)^2$

$(44.3)^2 = (27.7)^2 + (30.8)^2$

$1962.49 \text{ cm}^2 \quad 1715.93 \text{ cm}^2$ −0.5

$\frac{g.cm}{s}$ cm $\frac{g.cm}{s}$ cm

6. Is the collision elastic?

yes it is elastic collision

7. For an elastic collision between two equal masses where the target mass is initially at rest, the **angle** between the final momenta vectors P_0P_1 and T_0T_1 is 90°. **Measure** the angle and compare its value with **90°**.

$\Delta\theta = \left|\frac{\theta - 90}{90}\right| * 100\% = \left|\frac{85° - 90}{90}\right| * 100\% = 5.5\%$

* Experiment 7 (Rotational motion)

transational	Rotational
m (intertia of a body)	I (moment of intertia)
x	θ
v	ω
a	α
$\vec{F}$	$\vec{\tau}$

$\vec{\tau}$ = dyne.cm

I = g.cm³

α = rad/s²

ω = rad/s

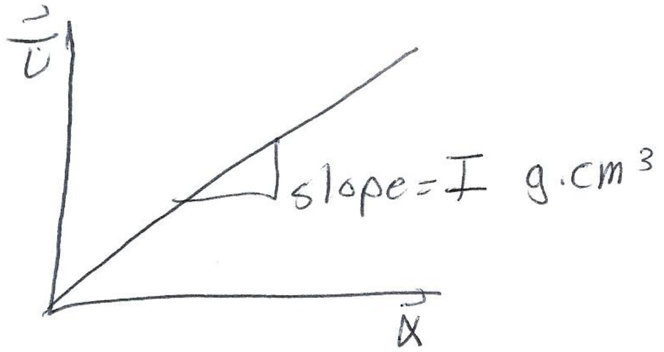
θ = rad

$a = r\alpha$

$V = r\omega$

$\vec{\tau} = I\alpha = TR$

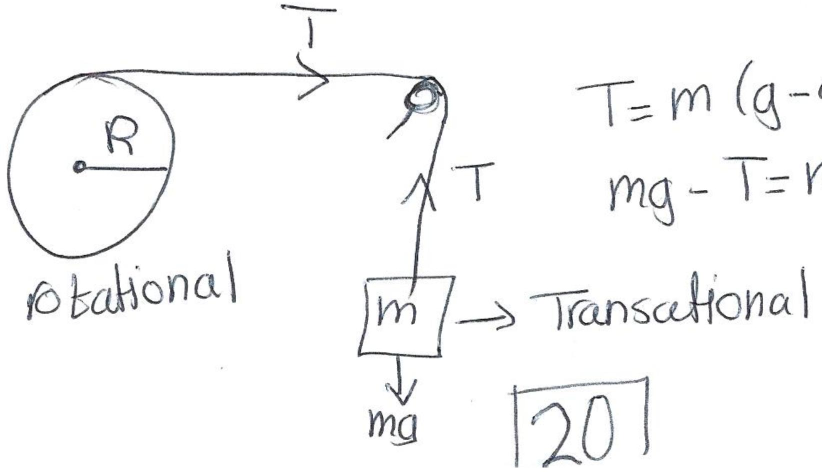
$\vec{r} \times \vec{F} = rF\sin\theta$



When α يزداد

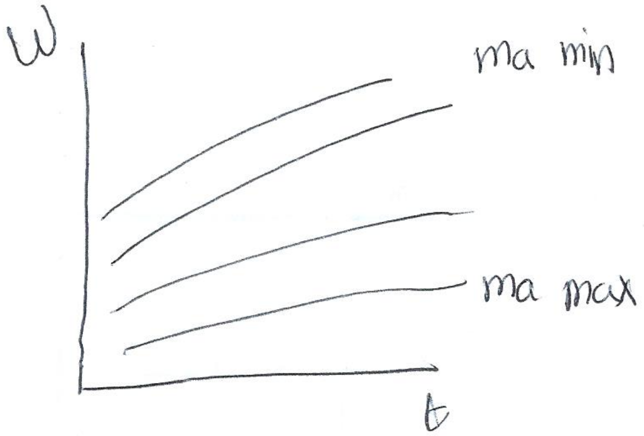
$\vec{\tau}$ يزداد

$\sum \vec{F} = m\vec{a}$



$T = m(g-a)$

$mg - T = ma$



كلما زادت ma قل α وزادت I

كلما زادت mh زادت α وقل I

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

$$\frac{1}{2} MR^2 = m_h R\left(\frac{g}{\alpha} - R\right)$$

$$\tau = m_h R(g - \alpha R)$$

$\tau = I\alpha$

τ = constant

I = variable

I	α

↓

m_h constant

$\vec{\tau}$ constant

$\tau = I\alpha$

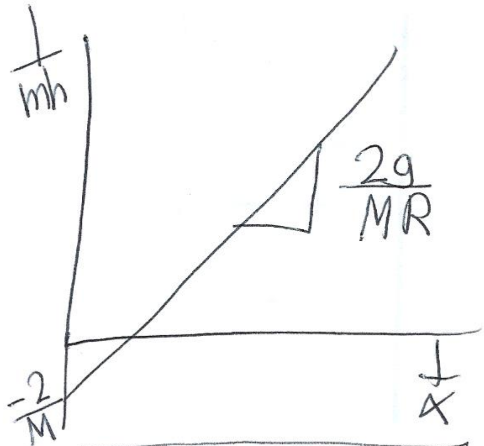
I = constant

τ = variable

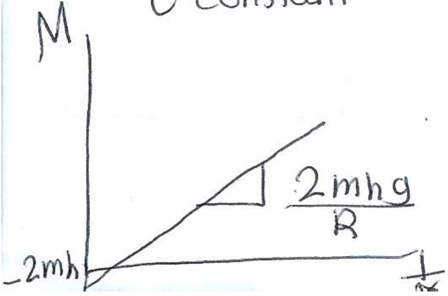
τ	α

M_{tot} constant

I constant



$$\boxed{\frac{1}{m_h} = \frac{2g}{MR}\frac{1}{\alpha} - \frac{2}{M}}$$



$$\boxed{M = \frac{2m_h g}{R}\frac{1}{\alpha} - 2m_h}$$

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

$$\frac{1}{2} M R^2 = m_h R\left(\frac{g}{\alpha} - R\right)$$

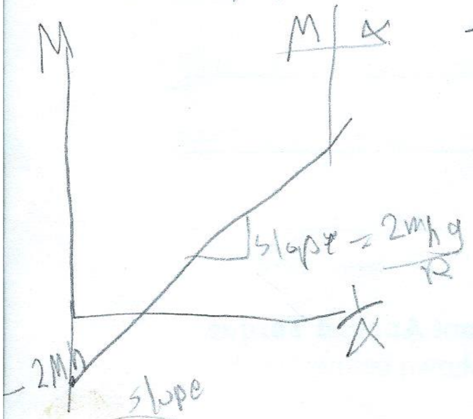
~~Disk ثابت عند الجزء الاول α وتقيس~~

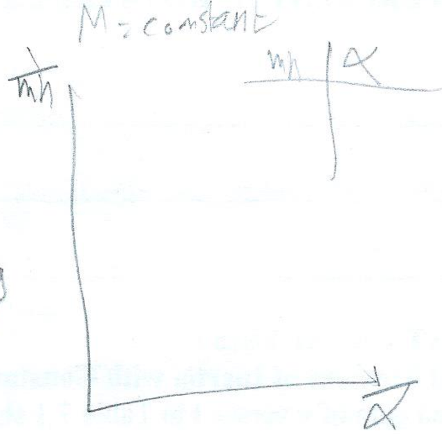
I = constant الجزء الاول

m_h = constant

I = constant الجزء الثاني

M = constant





$$\boxed{M = \frac{2M_h g}{R}\frac{1}{\alpha} - 2m_h}$$

y s x b

$$\frac{1}{m_h} = \frac{2g}{MR}\frac{1}{\alpha} - \frac{2}{M}$$

كلما زادت M تزداد I ويقل α

كلما زادت m_h يزداد α

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	ω = v/R rad/s	v cm/s	ω = v/R rad/s	v cm/s	ω = v/R rad/s
0.05	16	1.344	21	1.76	32	2.68
0.15	28	2.35	41	3.44	68	5.71
0.25	38	3.19	63	5.29	105	8.82
0.35	47	3.94	80	6.72	138	11.59
0.45	62	5.21	102	8.57	171	14.36
0.55	70	5.88	123	10.33	204	17.14
0.65	82	6.89	136	11.42		

2. Use Table 7.3 to plot, on the **same sheet of paper**, the graphs of ω versus **t.**

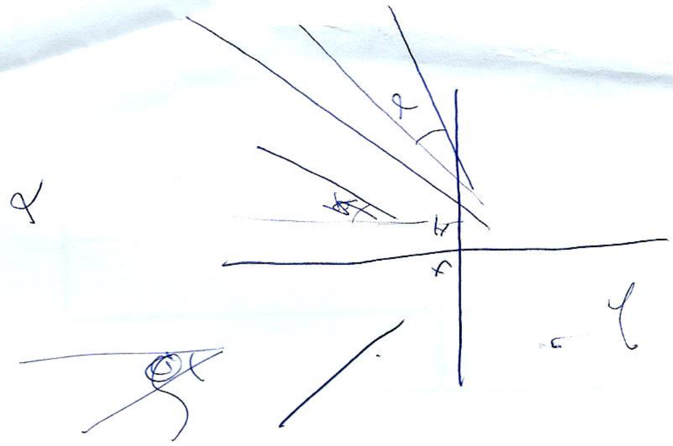
3. What do you conclude from your graphs?

When the torque increases (the hanging mass increased) the angular acceleration increase

$m_h \propto \alpha$

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

5. Enter your results in Table 7.4 below:



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

$$\frac{1}{2} M R^2_{\text{ondisk}} = m_h R\left(\frac{g}{\alpha} - R\right)$$

$$y = s x + b$$

$$M = 2\frac{m_h}{R} g \frac{1}{\alpha} - 2 m_h \Rightarrow \tau = \text{constant}$$

$$\frac{1}{m_h} = \frac{2g}{MR}\frac{1}{\alpha} - \frac{2}{M} \qquad I = \text{constant}$$

$$y = s x + b$$

LAB REPORT FOR EXPERIMENT 7

Date: 26/12/2013

Name: Zeina Mansour **Partner's Name:** Areen

Registration No: 0133014 **Registration No:**

Physics Section: 17 **Instructor's Name:**

PHYSICS LAB EXPERIMENT 7: ROTATIONAL MOTION

I. PURPOSE :

To investigate how the angular velocity of a rotating disc varies with time when a torque acts on it and how to use the results of the experiments to calculate the moment of inertia of the disc

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:

$m_h = 50$ m added = 0 / m added = 200

Table 7.1

I constant $r = 11.9$ I_n

	Added mass to the turntable					
	M = 0 g		M = 100 g		M = 200 g	
Time (s)	v cm/s	ω = v/R rad/s	v cm/s	ω = v/R rad/s	v cm/s	ω = v/R rad/s
0.05	16	~~190.4~~ 1.34	17	1.428	16	1.34
0.15	28	2.35	26	2.18	21	1.76
0.25	38	3.19	38	3.19	30	2.52
0.35	47	3.94	46	3.86	39	3.27
0.45	62	5.210	53	4.45	45	3.78
0.55	70	5.88	64	5.37	54	4.53
0.65	82	6.89	70	5.88	63	5.29
Radius of the turntable (R) = cm						

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?

When the added mass increase the angular acceleration decreese) (invese relation) $m_a \propto \frac{1}{\alpha}$

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 Ineria I (g .cm^2)
0		
100		
200		

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

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

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?

When the added mass increase, the moment of inertia increase (direct relation), $m_a \propto I \Rightarrow I = mr^2$

also, When the angular acceleration decrease the moment of inertia increase, $\alpha \propto \frac{1}{I}$

Table (7.4)

Total Hanging Mass m (g)	Angular Acceleration α (rad/s ^{2})	Torque (τ) = Rm(g-αR) (dyne.cm)
50		
100		
150		

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

7. What do you conclude from your graph?

mh α ~~α~~

τ α α(direct relation)

When the angular acceleration increase, the torque increase

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

The moment of inertia of empty turntable = slope

$\frac{\Delta \tau}{\Delta \alpha}$ = g.cm ^{3}

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

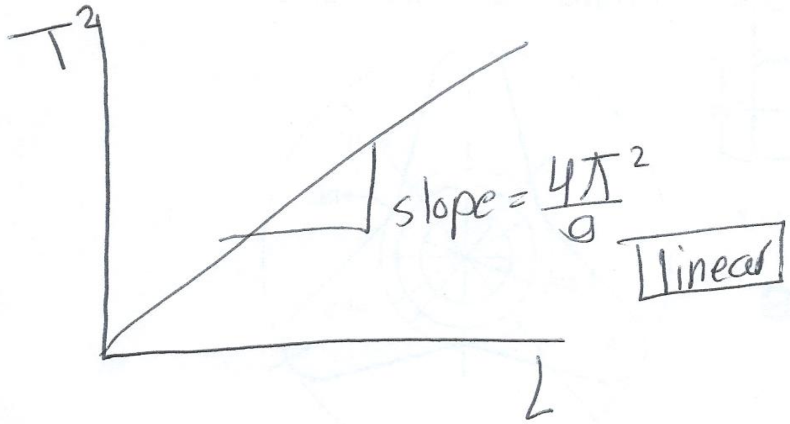
Yes it is a litte less than in part A.

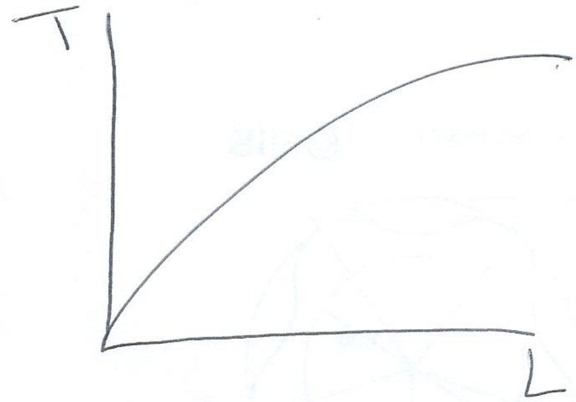
percent difference = $\frac{| \quad |}{(\quad)/2} \times 100\%$

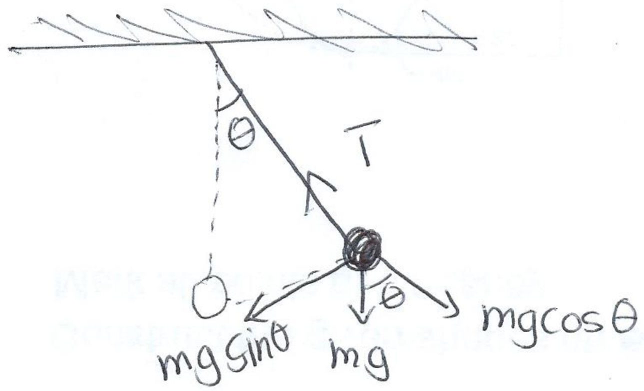
* Experiment 8 simple Harmonic motion
اهتزازية

$$T = 2\pi \sqrt{\frac{L}{g}}$$

الزمن الدوري







$$T - mg\cos\theta = \frac{mv^2}{L^2}$$

القوى المركزية

$$F_r = \frac{mv^2}{r}$$

* Tangential force

$$F_t = mg\sin\theta$$

changing the mass doesn't change the period of vibrations

LAB REPORT FOR EXPERIMENT 8

Date: 26/12/2014

Name: Zeina Mansour

Partner's Name: Areen

Registration No: 0133014

Registration No:

Physics Section: 17

Instructor's Name:

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

I. PURPOSE :

To study the relation between time and length of pendulum

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 $\overline{T}$ and the lengths L in table 8.2.

Table 8.1

	L_1= cm	L_2= cm	L_3= cm	L_4= cm	L_5 = cm	L_6 = cm
Trial No.	t /20 (s)	t /20 (s)	t /20 (s)	t /20 (s)	t /20 (s)	t /20 (s)
1						
2						
3						
4						
5						
	$\bar{T}_1$ = s	$\bar{T}_2$ = s	$\bar{T}_3$ = s	$\bar{T}_4$= s	$\bar{T}_5$= s	$\bar{T}_6$= s

Table 8.2

L (cm)	$\bar{T}$ (s)	$\bar{T}^2$ (s^2)

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?

When

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

linear relation

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

The slope-

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

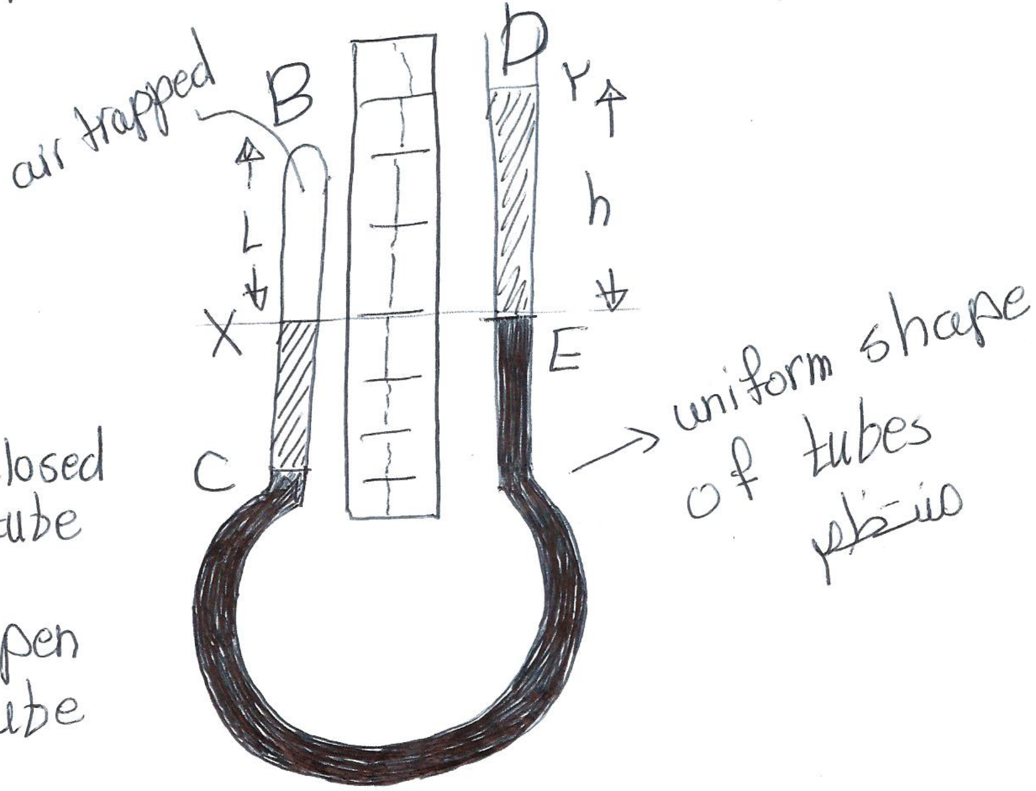
8. Estimate the **error in g**.

* Experiment 9 (The laws of gases)

- The behavior of simple gases under changes in the temperature or pressure

* Boyle's law

- The variation in volume of entrapped gas (air) with pressure under constant room temperature



BC → closed tube

DE → open tube

X → mercury level in the close tube

Y → mercury level in the open tube

h = Y − X (difference of mercury levels)

+ or −

X / Y → mm

L = B − X → mm

h = Y − X → mm

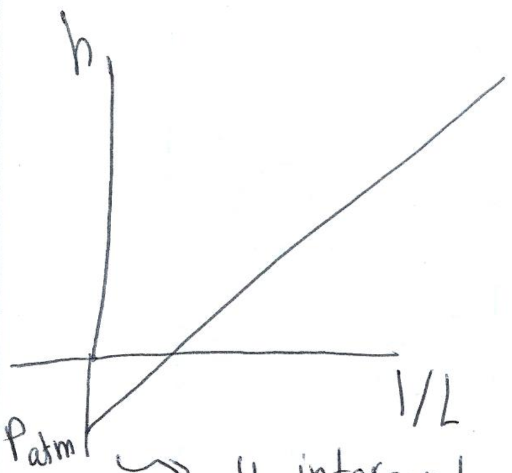
Temp (°c)

$$\boxed{h = \frac{nRT}{A} * \frac{1}{L} - P_a}$$

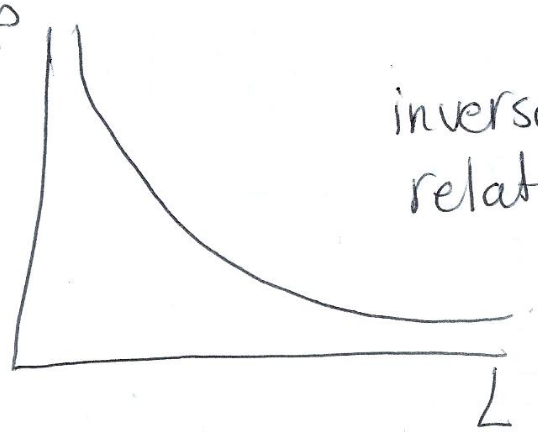
* volume of entrapped gas is $V = A L$

area — length of the entrapped gas column

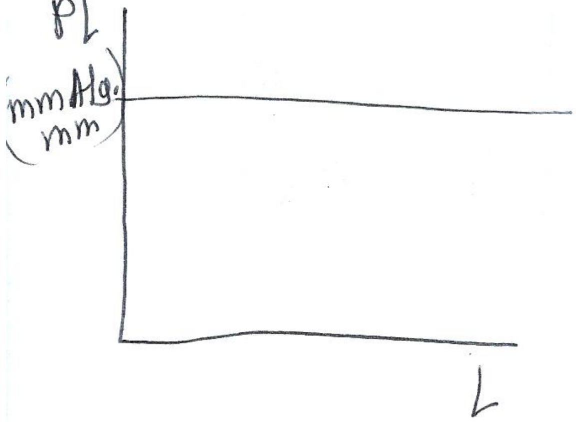
* pressure of entrapped gas $P = P_{atm} + h$



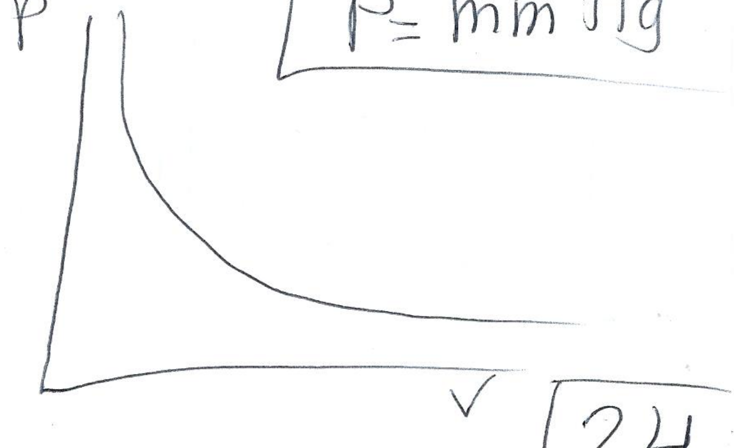
→ y intercept



inverse relation



$$\boxed{P = mm\,Hg}$$



9

LAB REPORT FOR EXPERIMENT 9

Date: 4/12/2013

Name: Zeina Mansour

Partner's Name: Areen

Registration No: 0133014

Registration No: 0130226

Physics Section: 17

Instructor's Name:

PHYSICS LAB EXPERIMENT 9: THE LAWS OF GASES

I. PURPOSE :

to investigate the behavior of simple gases, sush 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)

مستوى الانبوب المسكر

Scale Readings (mm) مسكر	انبوب مفتوح	L = B-X (mm) (300)	h = Y-X (mm)	1/L (mm^{-1})
X	Y			
185	800 mm	L = 300 − 185 = 115	h = 800 − 185 = 615	= 1/115 = 8.6 × 10^{-3}
178	700 mm	= 300 − 178 = 122	= 700 − 178 = 522	= 1/122 = 8.1 × 10^{-3}
167	600 mm	= 300 − 167 = 133	= 600 − 167 = 433	= 1/133 = 7.5 × 10^{-3}
156	500 mm	= 300 − 156 = 144	= 500 − 156 = 344	= 1/144 = 6.9 × 10^{-3}
144	400 mm	= 300 − 144 = 156	= 400 − 144 = 256	= 1/156 = 6.4 × 10^{-3}
129	200 mm	= 300 − 129 = 171	= 300 − 129 = 171	= 1/171 = 5.8 × 10^{-3}

B = 300 mm

Average Room Temp. = 20 °C

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

Pa = 725 ± mm. Hg

⇓ y-intercept

-0.5

3. Calculate the pressure of the entrapped gas **P** in each case, using the relation: $\mathbf{P = (P_a + h)}$ 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)
115	P = 725 + 615 = 1340	154100
122	P = 725 + 522 = 1247	152134
133	P = 725 + 433 = 1158	154014
144	P = 725 + 344 = 1069	153936
156	P = 725 + 256 = 981	153036
171	P = 725 + 171 = 896	153216

15

2

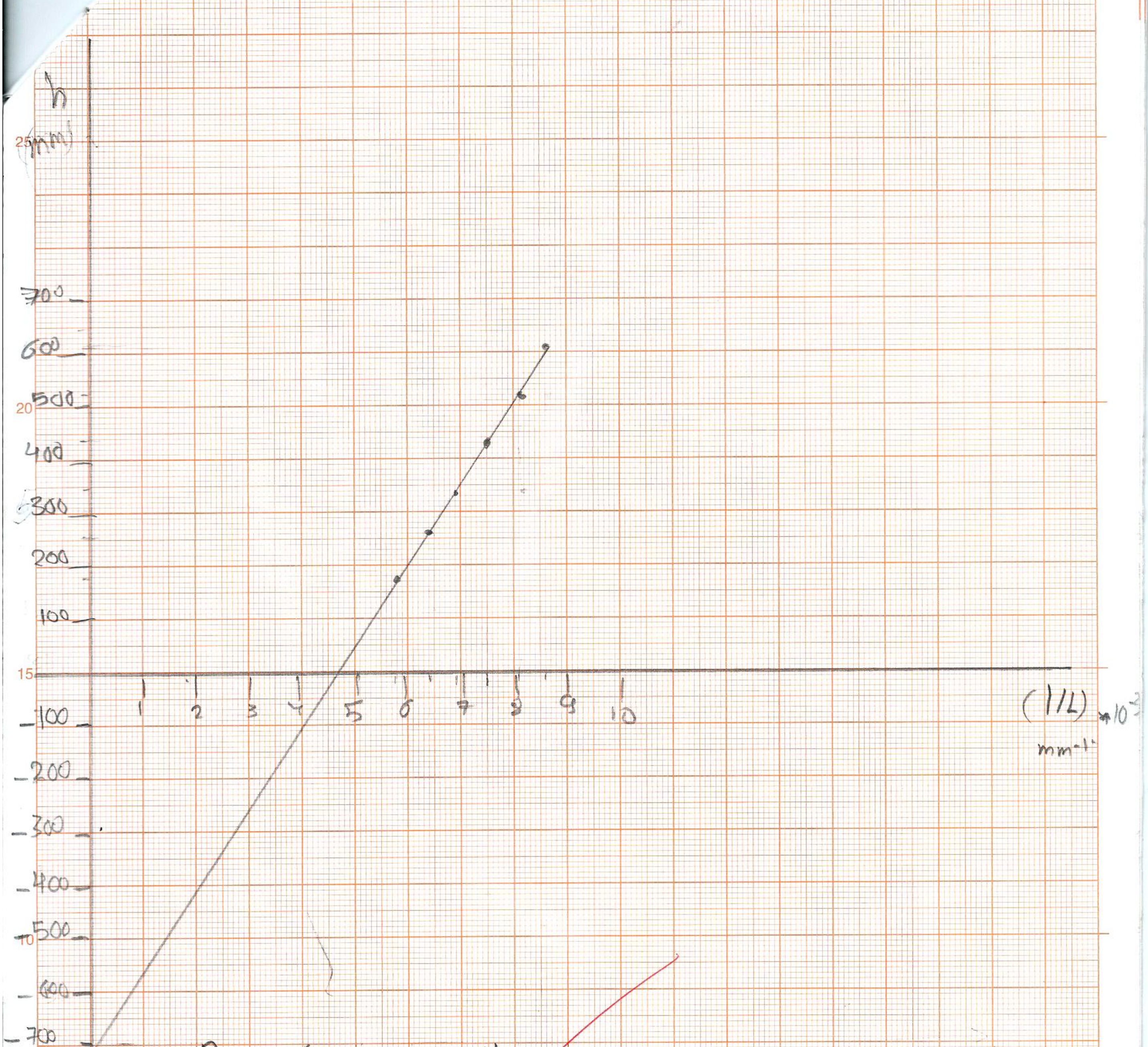
1

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

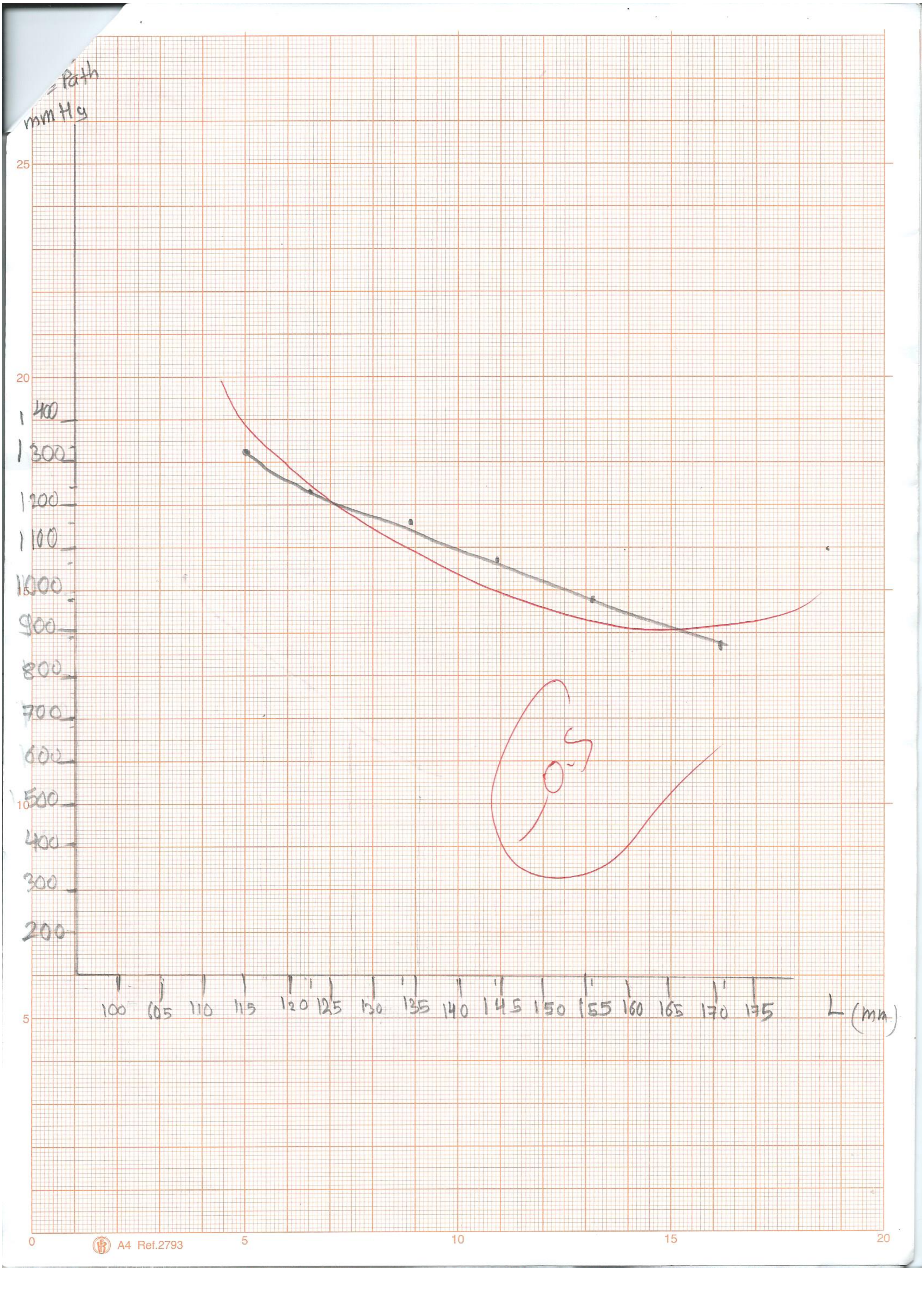
that P (pressure) decreases as L increases (inverse relation)

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

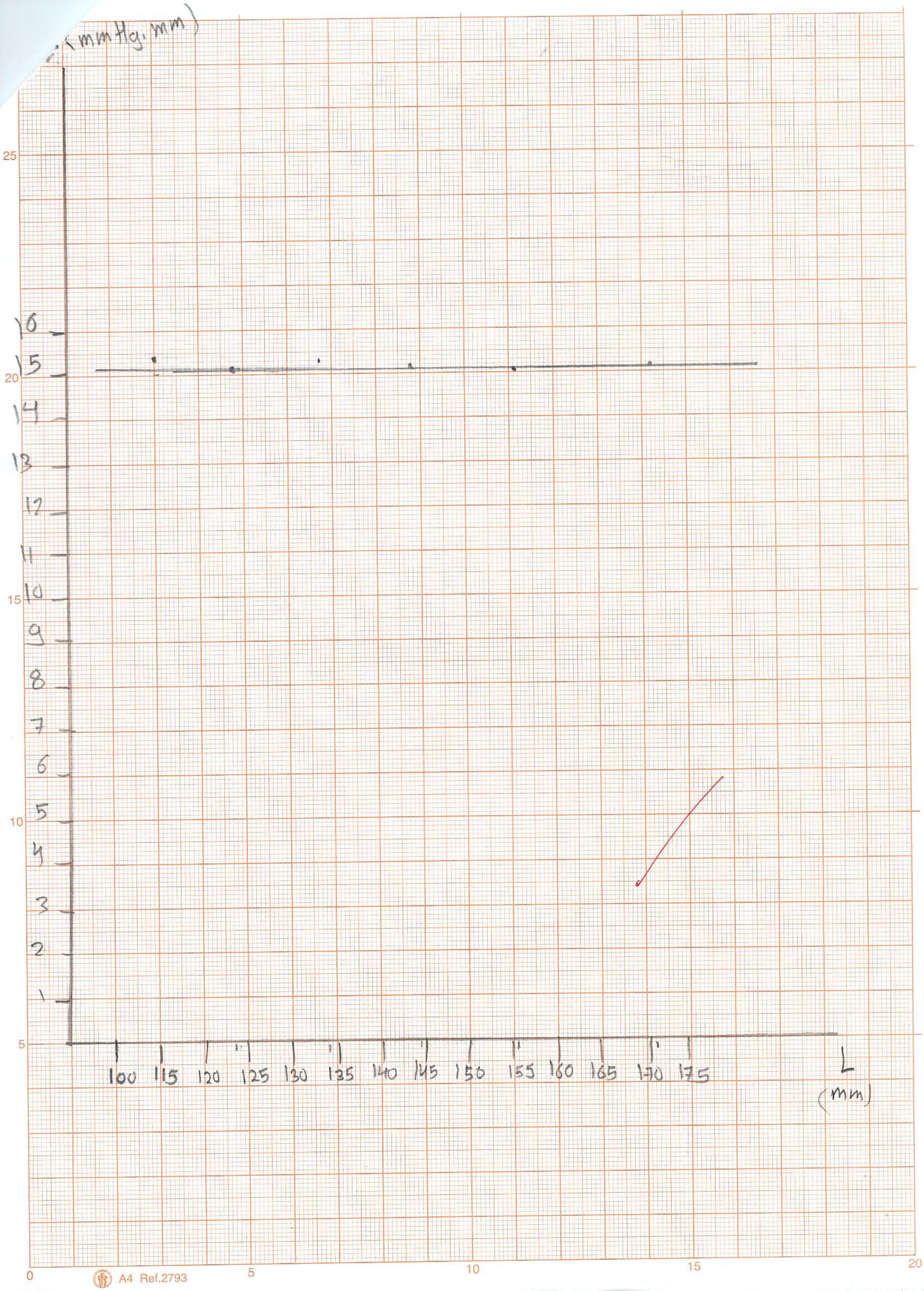
PL is constant and is ≈ 15


h (mm)
700
600
500
400
300
200
100
-100
-200
-300
-400
-500
-600
-700
-725
1
2
3
4
5
6
7
8
9
10
(1/L) ×10⁻³ mm⁻¹

$P_a = (725)$ mm Hg



Path
mmHg
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
105
110
115
120
125
130
135
140
145
150
155
160
165
170
175
L (mm)
0.5
0
5
10
15
20
25
A4 Ref.2793


(mmHg.mm)
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
100 115 120 125 130 135 140 145 150 155 160 165 170 175
L
(mm)

* Experiment 11 (specific heat capacity)

→ specific heat capcity (C) → quantity of heat required to rais the temp. of one gram of a substance by $1°c$

$[C] = cal/(g.c°)$

→ Heat capcity $= mc = [cal/c°]$

→ Heat $= Q = mc\Delta T$ ⇒ كمية الطاقة اللازمة لرفع درجة الحرارة لـ m غرام من مادة سعتها الحرارية C بمقدار ΔT درجة من دون تغيير حالتها الفيزيائية

$Q = cal$ or J

$(1 cal = 4.18 J)$

⇒ Heat absorbed by one part of a system = Heat lost by the other part of the same system

Q gained by water & calometer = Q lost by metal

$$m_w c_w \Delta T_w + m_1 c_1 \Delta T_1 = m_2 c_2 \Delta T_2$$

$[T_2 - T_f]$

$$\Delta T_c = \Delta T_w$$

$$(m_w c_w + m_1 c_1) \Delta T_{w,1} = m_2 c_2 \Delta T_2$$

T_1: initial Temp. of Water & calometer.

T_2: initial Temp. of metal

T_f: equlibruim temp.

$X = m_w c_w + m_1 c_1$ $C^\circ = \frac{5}{9}(F - 32)$

$y = T_f - T_1$

$Z = T_2 - T_f$

$Xy = m_2 c_2 Z$

$$\boxed{c_2 = \frac{Xy}{Z m_2}}$$

$$\Delta c_2 / c_2 = \sqrt{\left(\frac{\Delta X}{X}\right)^2 + \left(\frac{\Delta y}{y}\right)^2 + \left(\frac{\Delta Z}{Z}\right)^2 + \left(\frac{\Delta m_2}{m_2}\right)^2}$$

$$\Delta X = \sqrt{(c_1 \Delta m_1)^2 + (c_w \Delta m_w)^2}$$

$$\Delta y = \sqrt{(\Delta T_f)^2 + (\Delta T_1)^2}$$

$$\Delta Z = \sqrt{(\Delta T_2)^2 + (\Delta T_f)^2}$$

* possible source of error in experiment ?!

$\Rightarrow$ heat loss

$X = m_w c_w + m_1 c_1$

$C° = \frac{5}{9}(F - 32)$

$y = T_f - T_1$

$Z = T_2 - T_f$

$X y = m_2 c_2 Z$

$$\boxed{c_2 = \frac{xy}{Z m_2}}$$

$$\Delta c_2 / c_2 = \sqrt{\left(\frac{\Delta X}{X}\right)^2 + \left(\frac{\Delta y}{y}\right)^2 + \left(\frac{\Delta Z}{Z}\right)^2 + \left(\frac{\Delta m_2}{m_2}\right)^2}$$

$$\Delta X = \sqrt{(c_1 \Delta m_1)^2 + (c_w \Delta m_w)^2}$$

$$\Delta y = \sqrt{(\Delta T_f)^2 + (\Delta T_1)^2}$$

$$\Delta Z = \sqrt{(\Delta T_2)^2 + (\Delta T_f)^2}$$

* possible source of error in experiment ?!

$\Rightarrow$ heat loss

9.5

LAB REPORT FOR EXPERIMENT 11

Date: 31/10/2013

Name: Zeina Mansour

Partner's Name: Areen

Registration No: 0133014

Registration No: 0130226

Physics Section: 17

Instructor's Name: Wafaa

PHYSICS LAB EXPERIMENT 11: SPECIFIC HEAT CAPACITY OF METALS

I. PURPOSE :

to Determine the specific heat capacity of a substance OR the heat capacity of a substance

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	= 45.2 g
Mass of calorimeter + water	= 124.93 g
Mass of water M_w	= 79.73 g
Temp. of calorimeter. +water T_1	= 24° °C
Temp. of metal T_2	= 95 °C
Final Equilibrium Temp. T_f	= 28 °C
Mass of metal M_2	= 94.7 g

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

1. reading temperature

2. error in weight

3. Temperature transfer to surrounding area

lost of heat

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

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

$Q_m = Q_w + Q_c \Rightarrow C_m m_m \Delta T_m = (C_w m_w + C_c m_c)$

$C_m \times 94.7 \times (95-28) = (1 \times 79.73 + 0.22 \times 45.2) \times \Delta T_{cw} (28-24)$

$C_2 = \frac{358.6}{6344.9} = 0.056 \qquad C_2 = \frac{xy}{m_2 z} = 0.056$ cal/g.c°

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

$\frac{\Delta C_2}{C_2} = \sqrt{\left(\frac{\Delta x}{x}\right)^2 + \left(\frac{\Delta y}{y}\right)^2 + \left(\frac{\Delta z}{z}\right)^2}$

$= \sqrt{\left(\frac{1.125 \times 10^{-3}}{89}\right)^2 + \left(\frac{0.75}{4}\right)^2 + \left(\frac{0.75}{67}\right)^2}$

$= 0.1882$

$C_2 \pm \Delta C_2 =$ 0.056 ± 0.01

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

$C_2 = m_2 C_2 = 94.7 \times 0.056 = 5.350 \frac{cal}{C°}$

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

$Q = mC\Delta T$

$= 120 \times 0.22 \times (60 - 25)$

$= 924$ cal

$C^\circ = \frac{5}{9}(F - 32)$

$C = \frac{5}{9}(140 - 32)$

$= \frac{5}{9} \times 108$

$= 60$ C

$\Delta m_1 = \Delta m_2 = \Delta m_w = \frac{1}{2} \times 0.01$ gm $= 0.005$ gm

$\Delta T_1 = \Delta T_2 = \Delta T_f = \frac{1}{2} \times 1 = 0.5°$

$x = m_1 c_1 + m_w c_w \longrightarrow$

$= 45.2 \times 0.22 + 79.73 \times 1$

$= 89.6$

$\Delta x = \sqrt{(c_1 \Delta m_1)^2 + (c_w \Delta m_w)^2}$

$\Delta x = \sqrt{(0.22 \times 0.005)^2 + (1 \times 0.005)^2}$

$= 1.125 \times 10^{-3}$

$y = T_f - T_1 \longrightarrow$

$= 28 - 24 = 4$

$\Delta y = \sqrt{(\Delta T_f)^2 + (\Delta T_1)^2}$

$= \sqrt{(0.5)^2 + (0.5)^2}$

$= 0.75$

$Z = T_2 - T_f$

$= 95 - 28$

$= 67$

$\Delta Z = \sqrt{(\Delta T_f)^2 + (\Delta T_2)^2}$

$= 0.75$

LAB REPORT FOR EXPERIMENT 12

Date: 14/11/2013

Name: Zeina Mansour

Partner's Name: Areen

Registration No: 0133014

Registration No: ....

Physics Section: 17

Physics Section: ....

10/10

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).

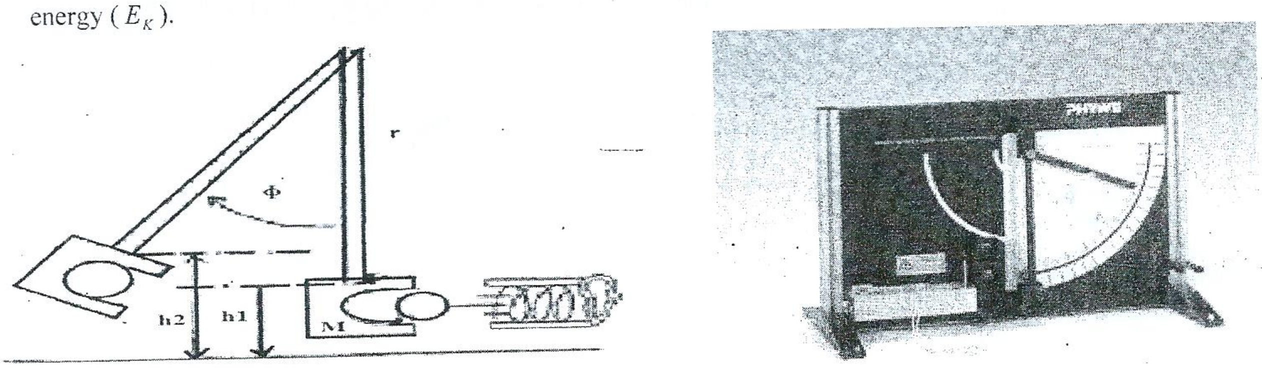


Figure 1

Applying the conservation of mechanical energy principle

$$\Rightarrow \quad E_S = E_K$$

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

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:

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

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

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

Where M_{tot}= M+ ma

Therefore ,

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

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):

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

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

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

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

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

$$U = (m + M_{tot}).g.\,r\,(1 - \cos(\Phi)) \qquad (8)$$

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

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

From this equality we get:

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

For eq. (4) we get

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

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 one 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: $E_{kin}= 1/2 . I .\omega^2$

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.

$E_{kin} = L^2/2I$. or $L=(2 . I . E_{kin})^{1/2}$.

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

$L_b = m \cdot r_b^2 \cdot \omega_b = m \cdot r_b \cdot v$

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

$\sqrt{2.I.(m+M_{tot})g.r.(1-\cos\Phi)}$

$\frac{M_{tot}}{m}\sqrt{2gr(1-\cos(\Phi))}.F_{cor}$ where is the factor (F_{cor}) $F_{cor} \cong 1$

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 ± 0.01g, M (mass of the pendulum) = 86 ± 0.01g and r = 24.00 ± 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.

Table 12.1

x (m)	x^2 (m^2)	k x^2 (Nm)	v (m/s)
0.02	0.0004	0.3	2.92
0.035	0.00122	0.915	5.11
0.05	0.0025	1.875	7.31
k = 750N/m		m = 0.035kg	

$V = \sqrt{\frac{Kx^2}{m_b}}$

$\sqrt{2.I.(m+M_{tot})g.r.(1-\cos\Phi)}$

$\frac{M_{tot}}{m}\sqrt{2gr(1-\cos(\Phi))}.F_{cor}$ where is the factor (F_{cor}) $F_{cor} \cong 1$

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-cosΦ 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 ± 0.01g, M (mass of the pendulum) = 86 ± 0.01g and r = 24.00 ± 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.

Table 12.1

x (m)	x^2 (m^2)	k x^2 (Nm)	v (m/s)
0.02	0.0004	0.3	2.92
0.035	0.00122	0.915	5.11
0.05	0.0025	1.875	7.31
k = 750N/m		m = 0.035kg	

$V = \sqrt{\frac{Kx^2}{m_b}}$

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.

Table 12.2

ma(kg)	M_{tot}=(M+ ma)	$(m/(M_{tot}+m))^2$	Φ	1-cosΦ
0	=0.086	0.083	48	0.330
0.01	=0.096	0.071	43	0.268
0.02	=0.106	0.061	37	0.201
0.03	=0.116	0.053	32	0.151
0.04	=0.126	0.047	37	0.108
m = 0.035kg		M = 0.086kg		

$V = \sqrt{}$

1. Use your data in table 12.2 to plot (1-cosΦ) versus $(m/(M_{tot}+m))^2$.
2. What conclusion can you obtain from your graph?

The relationship between (1-cos θ) and $(m/(M_{tot}+m))^2$ is linear.

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

$$\text{slope} = \frac{0.243 - 0.18}{0.07 - 0.057} = 4.8$$

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

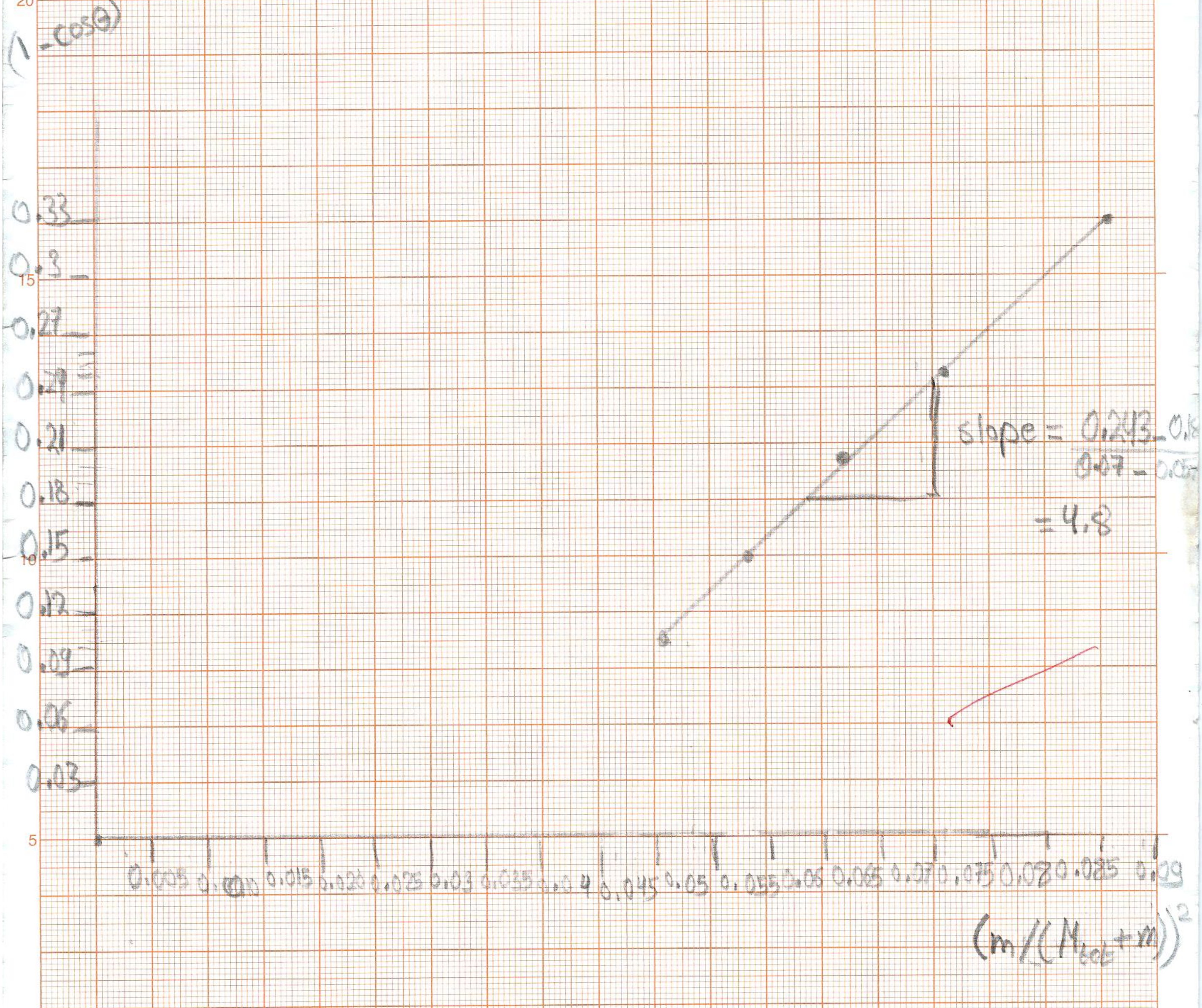
$$\text{slope} = \frac{v_b^2}{2gr} \qquad 4.8 = \frac{(5.11)^2}{2 \times g \times 0.24} \qquad g = \frac{(5.11)^2}{4.8 \times 2 \times 0.24}$$

$$= 11.3 \text{ m/s}^2$$

5. Estimate the error in g.

$$\text{percentage error} = \frac{|E - A|}{|A|} \times 100\%$$

$$= \frac{|11.3 - 9.8|}{|9.8|} \times 100\% = 15.3\%$$


(1-cosθ)
0.33
0.3
0.27
0.24
0.21
0.18
0.15
0.12
0.09
0.06
0.03
0.005
0.010
0.015
0.020
0.025
0.03
0.035
0.04
0.045
0.05
0.055
0.06
0.065
0.07
0.075
0.080
0.085
0.09
slope = 0.243 - 0.18
0.07 - 0.05
= 4.8
(m/(M_tot+m))^2

A4 Ref.2793