Hooke's Law (القانون هوك)

Room No: 1A31

Objective- To determine the spring constant ثابت زنبرك (k) by Hooke's law.

Formula used-

Part-1 (Spring Constant by Hooke's law)

Total force on the spring after putting some weight (for table 1)

$$F + F' = 0$$

$$mg - k\Delta L = 0$$

$$mg = k\Delta L$$

$$\Delta L = \frac{g}{k}.m$$

Compare with $y = m\,x$, we get

$$Slope = \frac{g}{k}$$

So, $\boxed{k = \dfrac{g}{Slope}}$ **for table1**

Where $g = 9.8$ m/s^2

Observation table-1

m (kg) x 10^{-3} **(x-axis)**	ΔL increase (m) x 10^{-2}	ΔL decrease (m) x 10^{-2}	ΔL average (m) x 10^{-2} **(y-axis)**
50			
100			
150			
200			

Part-2 Spring Constant by time oscillation

When the weight oscillates into the spring, the equation is defined as

$$T = 2\pi\sqrt{\frac{m + m_0}{k}}$$

$$T^2 = \frac{4\pi^2}{k}(m + m_0)$$

$$T^2 = \left(\frac{4\pi^2}{k}\right) m + \frac{4\pi^2 m_0}{k}$$

Compare with $y = m\,x + C$

$$\text{Slope} = \frac{4\pi^2}{k}$$

$$C = \frac{4\pi^2 m_0}{k} \Rightarrow C = Slope \text{ x } m_0 \Rightarrow m_0 = \frac{C}{Slope}$$

Where C is Y-intercept

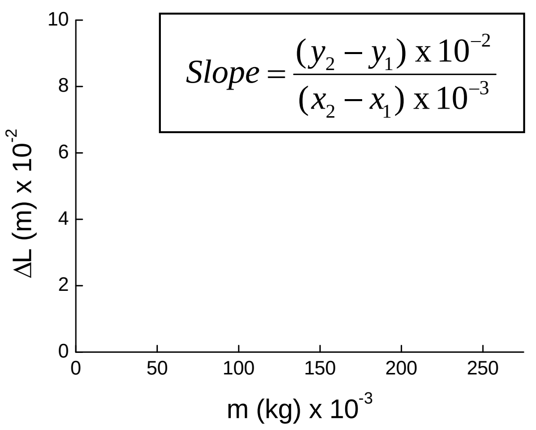
$$\boxed{k = \frac{4\pi^2}{Slope}}$$

for table2

Observation table-2

m (kg) x 10^{-3} **(x-axis)**	**t_1(Sec)**	**t_2 (Sec)**	**t_3 (Sec)**	**t (Sec)**	**T=t/10 (Sec)**	**T^2 (Sec^2) x 10^{-2}** **(y-axis)**
50						
100						
150						
200						

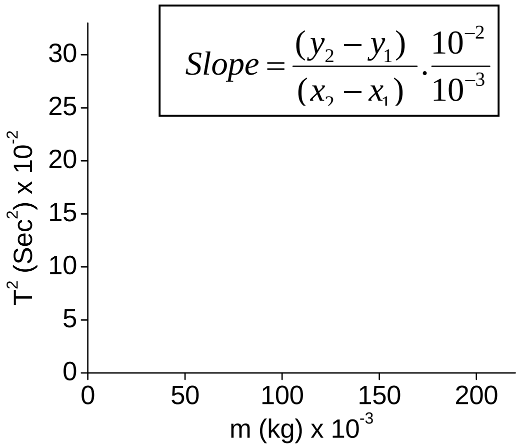
Graph-1



$$\boxed{Slope = \frac{(y_2 - y_1) \text{ x } 10^{-2}}{(x_2 - x_1) \text{ x } 10^{-3}}}$$

$$\boxed{k = \frac{g}{Slope}}$$

Graph-2



$$Slope = \frac{(y_2 - y_1)}{(x_2 - x_1)} \cdot \frac{10^{-2}}{10^{-3}}$$

$$k = \frac{4\text{®}^2}{Slope}$$

Result-1 $\quad k = \dfrac{g}{Slope} = \dfrac{9.8}{(.......)} (N/m)$

Result-2 $\quad k = \dfrac{4\text{®}^2}{Slope} = \dfrac{39.5}{(.......)} (N/m)$

2

Boyle's Law (القانون بويل)

PHY-103

Room No: 1A20

Objective- To determine the atmospheric pressure (الضغط الجوي) (P_a) by Boyle's law.

Formula used-

$$PV = \text{constant}$$

Where $\text{constant} = (h+P_a).(l.a)$

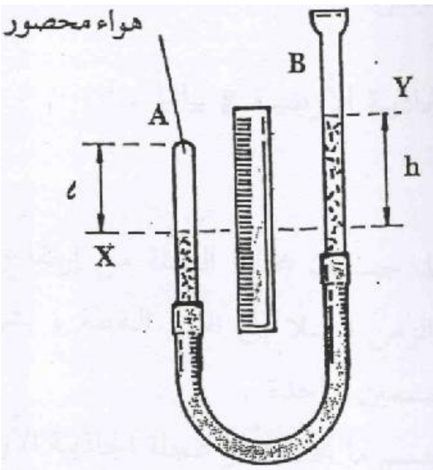
So, $PV = (h+P_a).(l.a)$

$$\frac{1}{l} = (h+P_a).\left(\frac{a}{PV}\right)$$

Say $\left(\frac{a}{PV}\right) = D$

$$\frac{1}{l} = (h+P_a).\,D$$

$D \neq 0$ So, $(h+P_a) = 0 \Rightarrow \boxed{P_a = -h}$



Boyle's experiment

Observation table

$y > x$

A (cm)	x (cm)	y (cm)	$h = (y - x)$ (cm. Hg) **(x-axis)**	$l = (A - x)$ (cm)	$\frac{1}{l}(cm^{-1})$	$\frac{1}{l}(cm^{-1}).10^{-2}$ **(y-axis)**
60						
60						
60						
60						
60						
60						

Graph

x-axis: 1 cm= 2 (cm.Hg)

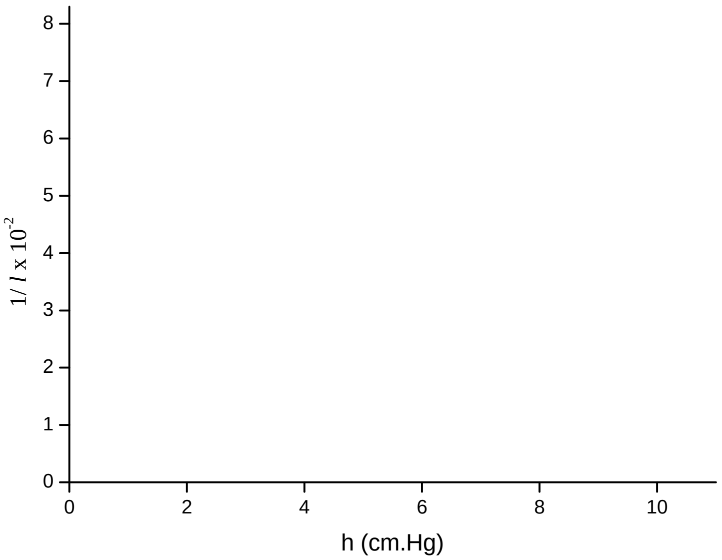
y-axis: 1 cm= 1 x 10^{-2} (cm^{-1})

$$a = slope = \frac{(y_2 - y_1)}{(x_2 - x_1)} \text{ x } 10^{-2} = (......) \text{ x } 10^{-2}$$

$$b = Intercept = (.......) \text{ x } 10^{-2}$$

$$h = -b / a = -(.......)$$

$$Pa = -h = -(-(......)) = (........)\ (cm.Hg)$$



Result: Atmospheric pressure is found to be P_a =.......... (cm.Hg)

3

Free fall (السقوط الحر)

Room No: 1A24

Objective- To determine the acceleration due to gravity تسارع الجاذبية الأرضية (g) by free fall.

Formula used-

Distance travelled by any object in particular time *t* is given by

$$S = ut + 1/2\, g' t^2$$

At start $u = 0 \Rightarrow S = 1/2\, g' t^2$

$$t^2 = \frac{2}{g'} . S$$

Compare with $y = m\,x$, we get

$$Slope = \frac{2}{g'}$$

So, $\boxed{g' = \frac{2}{Slope}}$

where,

g = **9.8** m/s^2 (theoretical value of g)

g' = experimental value of g

Observation table

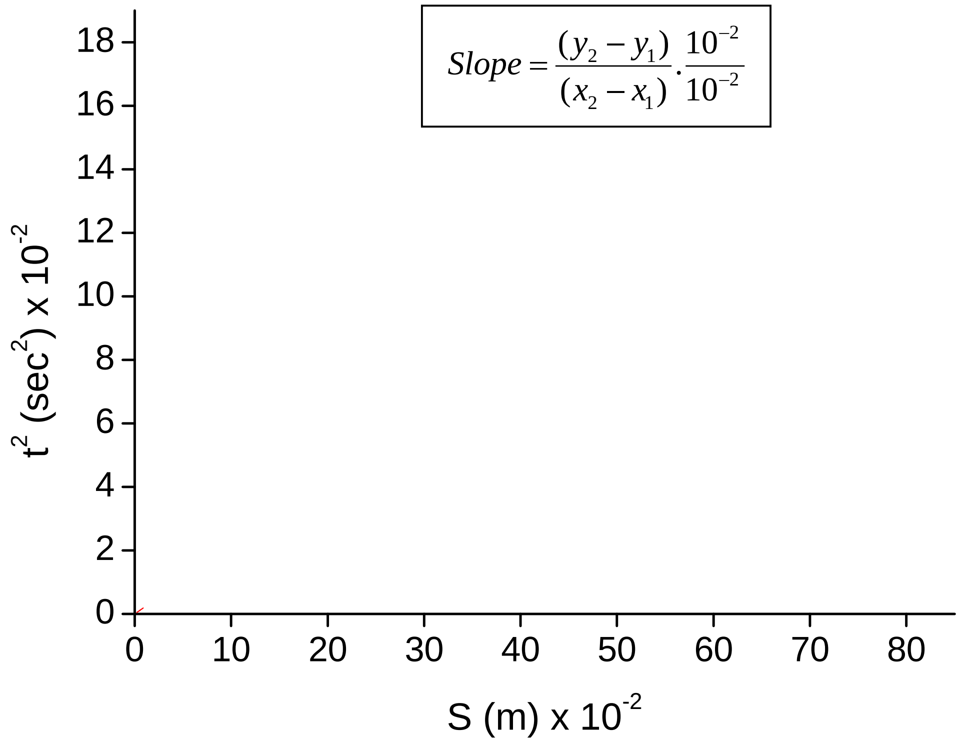
S x 10^{-2}(m) **(x-axis)**	**t_1 x10^{-3} (sec)**	**t_2 x10^{-3} (sec)**	**t_3x10^{-3} (sec)**	**t x10^{-3} (sec)**	$\frac{t^2(sec^2)}{10^4}$ **. 10^{-6}. 10^4**	**t^2 (sec^2) x 10^{-2}** **(y-axis)**
80						
70						
60						
50						
40						

Graph

X-axis: 1cm=10 x 10^{-2} (m)

Y-axis: 1cm=2 x 10^{-2} (sec^2)

$$Slope = \frac{(y_2 - y_1)}{(x_2 - x_1)} \cdot \frac{10^{-2}}{10^{-2}}$$



Result:

$$g' = \frac{2}{Slope} = \frac{2}{(.....)} = ...\,(m/\sec^2)$$

$$\%\,error = \frac{|g - g'|}{g} \text{ x } 100 = \frac{|9.8 - ......|}{9.8} \text{ x } 100 = ...\,\%$$

4

Viscosity (معامل اللزوجة)

Room No: 1A26

Objective- To determine the coefficient of viscosity (η) for pure glycerine by Stokes' law.

Formula used-

Force on the steel balls (downward)

$$F_1 = mg = V\rho g = \frac{4}{3}\pi r^3 \rho_s g$$

Force exerted on ball due to liquid/fluid (upward)

$$F_2 = \frac{4}{3}\pi r^3 \rho_L g$$

Drag force by Stokes' law exerted on the spherical objects in a continuous viscous fluid (upward)

$$F_3 = 6\pi \eta v_t r$$

So, balance the force

$$F_1 = F_2 + F_3$$

$$\frac{4}{3}\pi r^3 \rho_s g = \frac{4}{3}\pi r^3 \rho_L g + 6\pi \eta v_t r$$

$$(\rho_s - \rho_L).g.\frac{4}{3}\pi r^3 = 6\pi \eta v_t r$$

$$v_t = \frac{2}{9}.g\frac{(\rho_s - \rho_L)}{\eta}.r^2$$

Compare with $y = mx$, we get

$$slope = \frac{2}{9}.g\frac{(\rho_s - \rho_L)}{\eta}$$

So, finally $$\boxed{\eta = \frac{2}{9}.g(\rho_s - \rho_L).\frac{1}{slope}}$$

where, g = 9.8 m/s^2

ρ_s = density of solid ball = 7800 kg/m^3

ρ_L = density of liquid glycerine = 1260 kg/m^3

$r = \frac{D}{2}$ = radius of balls

s = distance from 140 – 70 = 70 cm (fixed)

v_t = (s / t) x 10^{-2} (m/s)

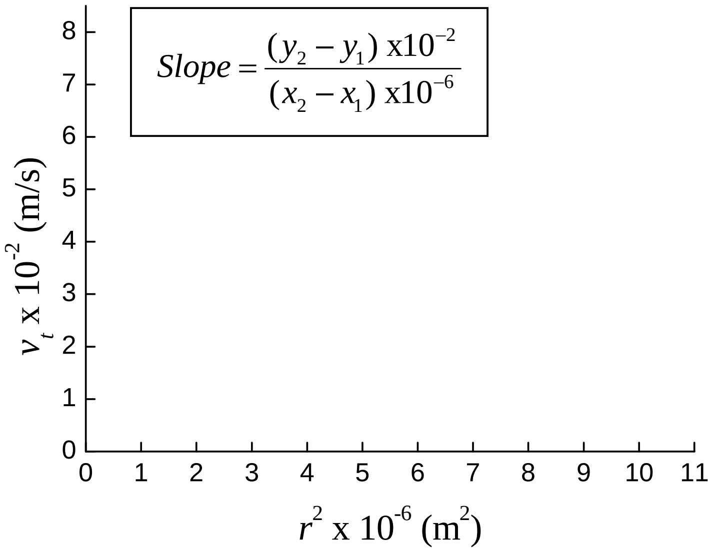
Observation table

D (m) x 10^{-3}	***r* = D/2 (m) x 10^{-3}**	**r^2 (m^2) x 10^{-6} (x-axis)**	**t_1 (sec)**	**t_2 (sec)**	**t_3 (sec)**	***t* (sec)**	**v_t = (s/t) x 10^{-2} (m/s) (y-axis)**
6.34							
4.76							
3.97							
3.17							

Graph

x-axis: 1 cm= 1 x 10^{-6} (m^2)

y-axis: 1 cm= 1 x 10^{-2} (m/s)



Result:

$$\eta' = \frac{2}{9} . g\ (\rho_s - \rho_L) . \frac{1}{slope} \quad = \frac{2}{9} \text{x } 9.8 \text{ x } (7800 - 1260) \text{x} \frac{1}{(\ldots\ldots\ldots)}$$

= .... (Pa.sec)

η = **0.934** Pa.Sec (theoretical value) at 25°C

$$\%\ \text{error} = \frac{|\eta - \eta'|}{\eta} \text{x} 100 = \frac{|0.934 - \ldots\ldots|}{0.934} \text{x} 100 = \ldots\ldots.\%$$

5

Force table (طاولـة القــوى)

Room No: 1A30

Objective- To compare the resultant angle (θ_R) & resultant force (R) by practical, calculation and graphical methods.

Methods

(i) By practical

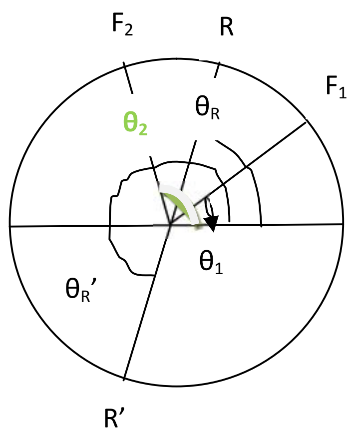
F_1 =........ gwt (say) & θ_1 = ...˚ (say)

F_2 =........ gwt (say) & θ_2 = ...˚ (say)

Put the weight F_1 & F_2 and on the other hand put the weight R until it balanced (Note down R). Adjust the ring at the centre that it did not touch anywhere.

R = ... gwt (balance & write)

Calculate $\theta_R = \theta_R' - 180 = ... - 180 = ...^0$



(ii) By calculation

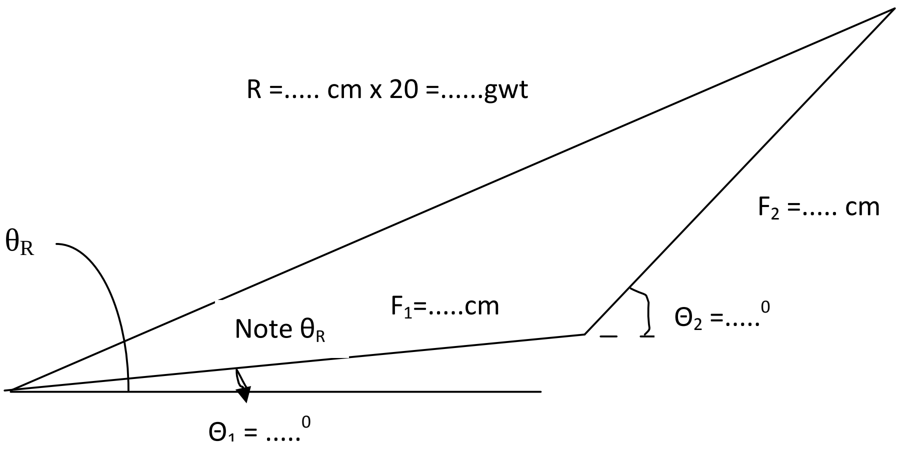
$$R = \sqrt{F_1^2 + F_2^2 + 2F_1F_2\cos(\theta_2 - \theta_1)} = ...\text{gwt}$$

$$\theta_R = \cos^{-1}\left(\frac{F_1\cos\theta_1 + F_2\cos\theta_2}{R}\right) = ...^0$$

(iii) By graphical

1 cm = 20 gwt => 1 gwt = 1/20 cm

F_1 = ... gwt = .../20 =..... cm at θ_1 = ...°
F_2 = ... gwt = .../20 =..... cm at θ_2 = ...°



Calculate R = 20 x ....= .... gwt

θ_R = (........)^0

Results

(Comparison table)

Method	θ_R (degree)	R (gwt)
Practical		
Calculation		
Graphical		

Simple Pendulum (البنـــدول البســـيط)

Room No: 1A42

Objective: To determine the acceleration due to gravity (g) by the Simple Pendulum.

Formula Used:

For small amplitudes the period of a simple pendulum depends only on its length and the value of the acceleration due to gravity

$$T = 2\text{®}\sqrt{L/g}$$

Where

T – Time period
L – Length of thread
g – Acceleration due to gravity

Making Square

$$T^2 = \frac{4\text{®}^2}{g}.L$$

Compare with y = m x we get Slope = $\frac{4\text{®}^2}{g}$

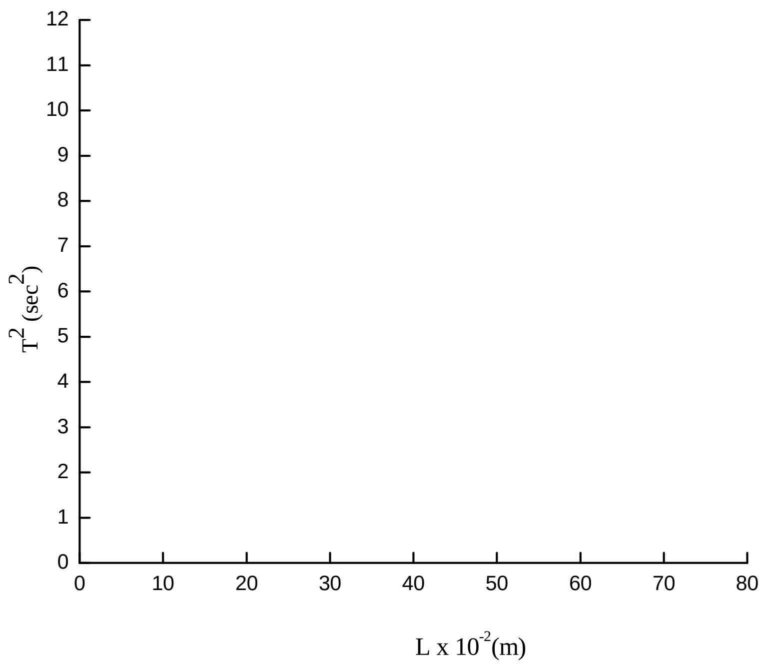
So, $\boxed{g = \frac{4\text{®}^2}{Slope}}$

Observation table

L x 10^{-2} (m) X-axis	**t_1(sec) for 10 Osc.**	**t_2 (Sec) for 10 Osc.**	**t_3 (Sec) for 10 Osc.**	**$\bar{t}$ (Sec)**	**T = $\frac{\bar{t}}{10}$ (Sec)**	**T^2 (sec^2) Y-axis**
40						
50						
60						
70						
80						

Graph

X-axis: 1cm=10 (m)
Y-axis: 1cm=1 (sec^2)



$$Slope = \frac{(y_2 - y_1)}{(x_2 - x_1)\times 10^{-2}} = \ldots\ldots\ldots$$

Result

So, the experimental value of g will be

$$g' = \frac{4\pi^2}{Slope} = \frac{4\pi^2}{.......} = \ldots\ldots.. \text{ (m/s}^2\text{)}$$

g = 9.8 (m/s^2) Theoretical value

Percentage Error

$$\%\ error\ = \frac{|g - g'|}{g}\times 100 = \frac{|9.8 - ....|}{9.8} \text{ x } 100 = ...\%$$

Planck's constant (ثابـــت بلانـــك)

Room No: 1A44

Objective: To determine the value of Planck's constant (h).

Formula Used:

Total energy of photons

$$E = K.E. + W_0$$
$$h\,f = eV_s + W_0$$

Cut off voltage/Stopping voltage

$$\boxed{V_s = \frac{h}{e}.f - \frac{W_0}{e}}$$

Where
$f = c/\lambda$ = frequency of light (Hz) or sec^{-1}
c – Speed of light = 3 x 10^8 m/s
e – Charge of electron = 1.6 x 10^{-19} C
λ – Wavelength of different light

Compare with $y = m\,x + c$

Slope = h/e

So, $\boxed{h = e \times Slope}$

Observation table

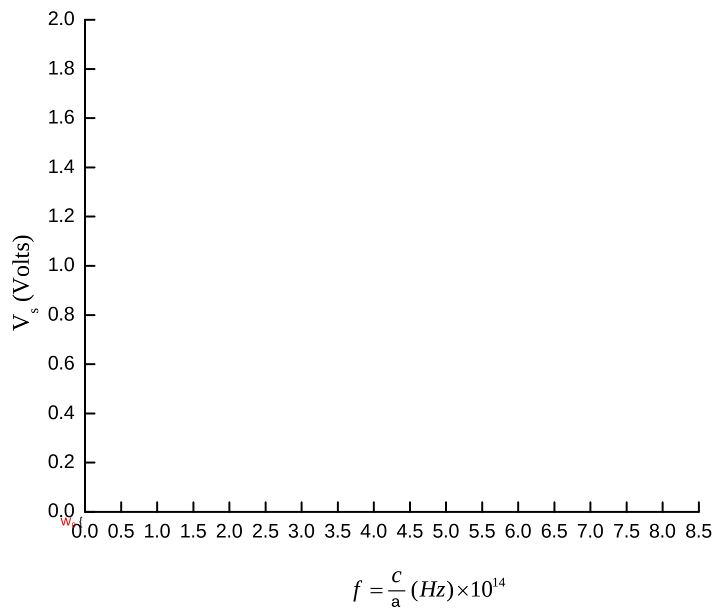
Color	**λ x 10^{-9} (m)**	$f = (c/\lambda)\times 10^{14}$ **(Hz)** **X-axis**	**Vs (V) (n=1)**	**Vs (V) (n=2)**	$\overline{V_s}$ **(Volts)** **Y-axis**
Yellow	578.00				
Green	546.07				
Blue	435.84				
Purple1	404.66				
Purple2	365.48				

Note:

(1) Use dark room.
(2) Use filters only for Yellow and Green light.
(3) Put the multimeter at 2V DC & switch on the h/e apparatus.

Graph

X-axis: 1cm=0.5 x 10^{14} (Hz)
Y-axis: 1cm=0.2 (Volts)



$$Slope = \frac{(y_2 - y_1)}{(x_2 - x_1)\times 10^{14}} = (.........)\text{x}10^{-14}$$

Result

Experimental value of Planck's constant

$$h' = e \times Slope = 1.6 \text{ x } 10^{-19} \text{ x } .... = ...(J.s)$$

Theoretical value of Planck's constant (h) is **6.626 x 10^{-34} J.s**

Percentage Error

$$\%\ error\ = \frac{|h - h'|}{h}\times 100 = \frac{|6.626 - ....|}{6.626}\times 100 = ...\%$$

Ohm's Law (قانون أوم)

Room No:1A45

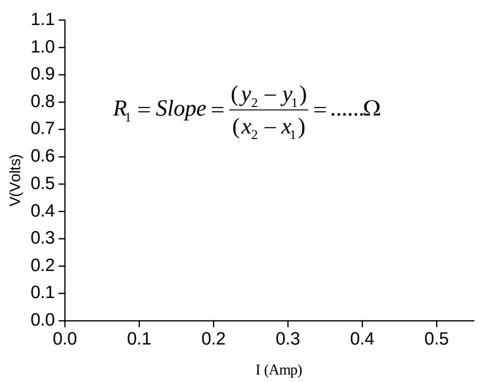
Objective: To verify the Ohm's law for series and parallel connections.

1. Ohm's Law

[For R_1=2 Ω]

I (Amp) x-axis	**V (Volts)** y-axis	**R_1= V/I (Ω)**
0.1		
0.2		
0.3		
0.4		
0.5		

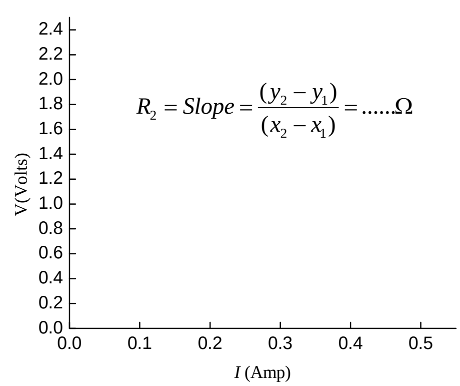
$$\overline{R_1} = \frac{\sum R_1}{5} = \frac{..........}{5} = ... \Omega$$



[For R_2=5 Ω]

I (Amp) x-axis	**V (Volts)** y-axis	**R_2= V/I (Ω)**
0.1		
0.2		
0.3		
0.4		
0.5		

$$\overline{R_2} = \frac{\sum R_2}{5} = \frac{.........}{5} = ... \Omega$$



Note: Plot graph only for this section.

2. Resistance in series connection

I (Amp)	V (Volts)	R_S= V/I (Ω)
0.1		
0.2		
0.3		

From experiment $\overline{R_S} = \frac{\sum R_S}{3} = ... \Omega$

In series connection $R_S = R_1 + R_2 = ... + ... = ... \Omega$

3. Resistance in parallel connection

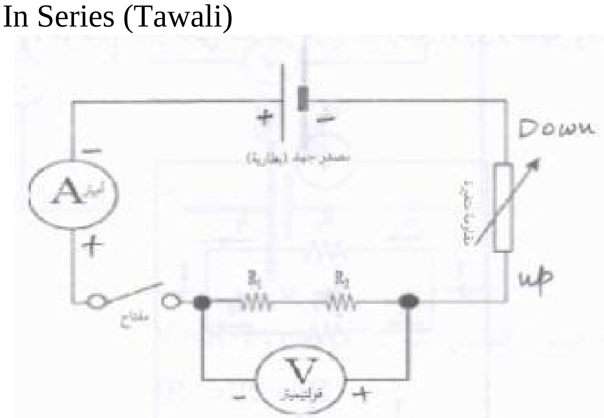
I (Amp)	V (Volts)	R_p= V/I (Ω)
0.1		
0.2		
0.3		

From experiment $\overline{R_p} = \frac{\sum R_p}{3} = ... \Omega$

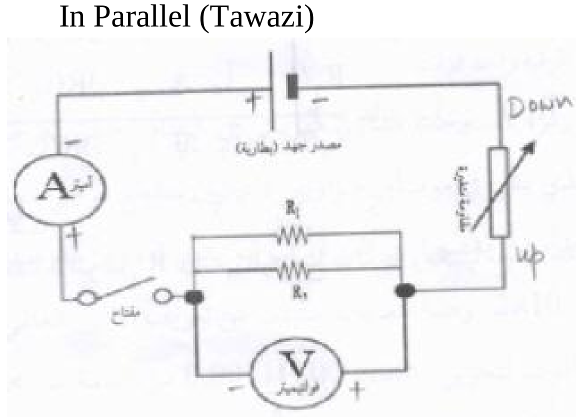
In parallel connection $R_p = \frac{R_1 R_2}{R_1 + R_2} = \frac{...........}{...........} = ... \Omega$

Circuit Diagrams

In Series (Tawali)



In Parallel (Tawazi)



Result: Ohm's law verified.

Absorption Coefficient of γ- rays (معامــل الامتصــاص)

Room No:1A46

Objective: To determine the absorption coefficient of γ- rays (μ).

Formula Used:

When a gamma ray passes through matter, the probability for absorption is proportional to the thickness of the layer, the density of the material, and the absorption cross section of the material. The total absorption shows an exponential decrease of intensity with distance from the incident surface:

$$I_c = I_{o\,c}\; e^{-\text{«}x}$$

$$\ln\left(\frac{I_{oc}}{I_c}\right) = \text{«}\; x$$

Compare with $y = m\,x$

$$\boxed{\text{«} = Slope}$$

where, x is the distance from the incident surface

μ = $n\sigma$ is the absorption coefficient, measured in cm^{-1}

Steps

(1) Background intensity [Put the Al sheet in the 2nd last row]

$$\overline{I_{BG}} = \frac{I_{BG1} + I_{BG2} + I_{BG3}}{3} = \frac{... + ... + ...}{3} = ...(C/\min)$$

(2) Original intensity [Put Pb source in the last row]

$$\overline{I_o} = \frac{I_{o1} + I_{o2} + I_{o3}}{3} = \frac{...... + ... + ...}{3} = ...(C/\min)$$

Source intensity without background

$$I_{oc} = \overline{I_o} - \overline{I_{BG}} = ... - ...... = ...(C/\min)$$

(3) Put Cobalt black slice 2 at a time above the Pb & Al sheet and note down I_1, I_2 & I_3 for observation table.

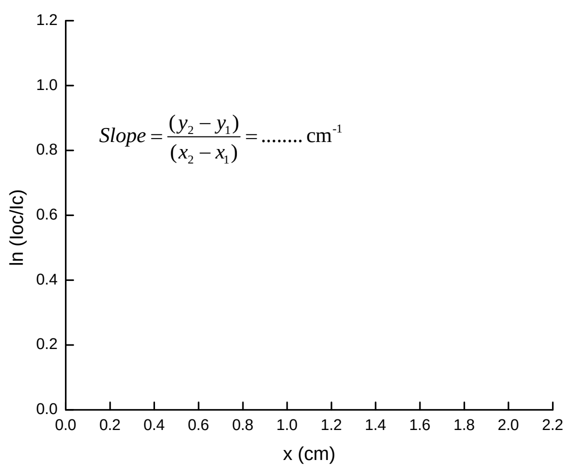
Observation table

No of Slice	x (cm) X- axis	I_1 (C/min)	I_2 (C/min)	I_3 (C/min)	$\bar{I}$ (C/min)	$I_c = \bar{I} - I_{BG}$	$\frac{I_{oc}}{I_c}$	$\ln\left({I_{oc}}/{I_c} \right)$ Y-axis
2	0.4							
4	0.8							
6	1.2							
8	1.6							
10	2.0							

Note:
(1) Set the Time 60 Sec.
(2) H.V. = 500 V
(3) Press H.V.
(4) Press count.
(5) Each Cobalt sheet has a thickness 0.2 cm.

Graph

X-axis: 1cm=0.2 (cm)
Y-axis: 1cm=0.2



Result

Apply this formula for absorption coefficient of Gamma-rays:

$$« = Slope = ... (cm^{-1})$$

Note: Press H.V. down to zero then switch off the machine. Don't switch off directly.

Capacitors (المكثفات)

Room No: 1B8

Objective: To determine the time constant (t) by charging of a capacitor.

Formula Used:

Equation for charging of a capacitor

$$V = V_0(1 - e^{-t/RC})$$

where

t – Time constant
R – Resistance = 1 MΩ
C – Capacitance = 100 μF

When t = RC

$$V = V_0(1 - e^{-1})$$

$$\boxed{V = 0.63\,V_0}$$

The theoretical value of time constant

t = RC = 1 MΩ x 100 μF = 1 x $\cancel{10}^6$ x 100 x $\cancel{10}^{-6}$ = **100 Sec**

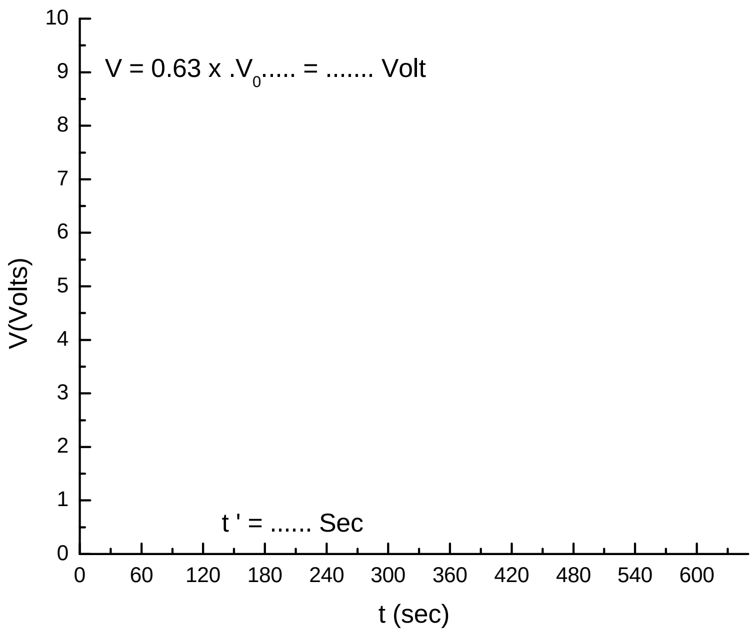
Observation table

t (Sec) **x-axis**	**V (Volts)** **y_1-axis (Graph-1)**	$\ln\left(\dfrac{V_0}{V_0 - V}\right)$ **y_2-axis (Graph-2)**
0		
30		
60		
90		
120		
150		
180		
210		

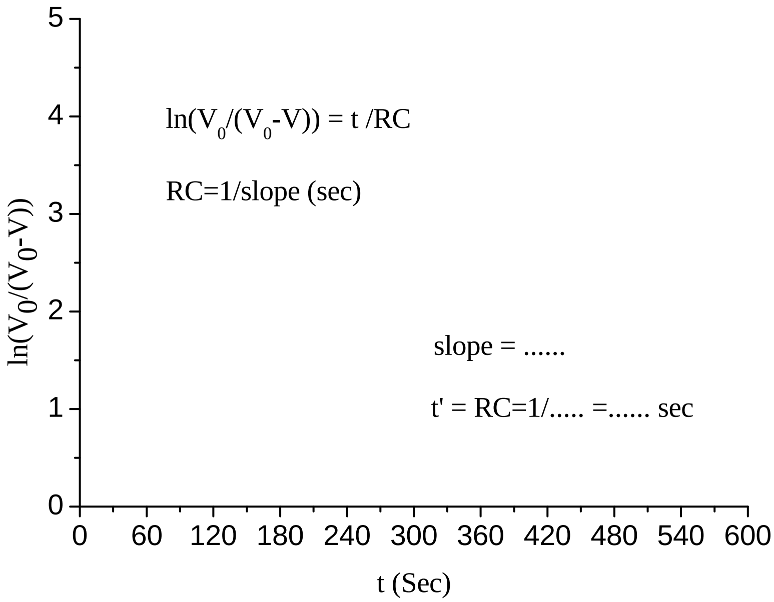
240		
270		
300		
330		
360		
390		
420		
450		
480		
510		
540		
570		
600	….. = V_0	

Graph

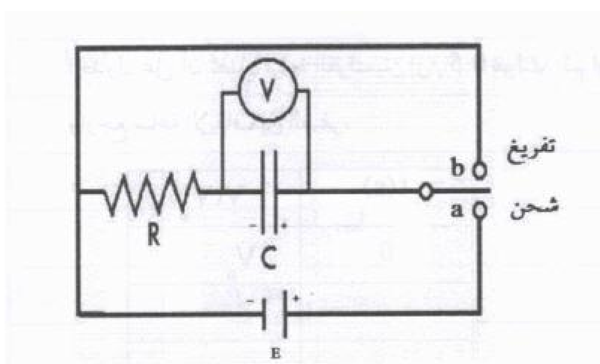
X-axis: 1cm=60 (sec)
Y-axis: 1cm=1 (Volts)



X-axis: 1cm=60 (sec)
Y-axis: 1cm=1



Circuit diagram



Note:

(1) First discharge the capacitor, if showing any voltage.
(2) Switch on green button & Voltmeter power button simultaneously (without stopping note down the *t* and V).
(3) Put on the voltmeter dc at 10 V.
(4) For Y_1-axis, divide the Multi-meter voltage by 10.
(5) 1 small block means 6 sec.

Result: We have found the time constant (t') = ……Sec for graph1 & (t') = ……Sec for graph2.