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United International University

Name: Sa'cheer Siddique ID: 011211057

Section: G Group: 4 Trimester: Spring 2022 Date: 17/04/2022

Experiment No. 01

Name of the Experiment: Determination of the refractive index of a liquid by plane mirror and pin method using a convex lens.

Theory:

If a convex lens is placed on a few drops of liquid on a plane mirror, then on squeezing the liquid into the space between the mirror and the lens, a Plano-concave liquid lens is formed. The curved surface of this liquid lens has the same radius of curvature as the surface of the lens with which it is in contact. Thus we have a combination of two lenses – one of glass and the other of liquid, which behaves as a convergent lens. If F be the focal length of the combination, then we have the relation

$$\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2} \quad \ldots\ldots\ldots (1)$$

where f_1 and f_2 are the focal lengths of the convex lens and the liquid lens respectively.

Correcting for the sign of f_2 which is negative, we get

$$\frac{1}{F}=\frac{1}{f_1}-\frac{1}{f_2}$$

$$\frac{1}{f_2}=\frac{1}{f_1}-\frac{1}{F} \quad \ldots\ldots\ldots (2)$$

Determining F and f_1 experimentally, we can calculate f_2 from relation (2).

The focal length of the plano-concave liquid lens is also given by relation

$$\frac{1}{f_2}=(\mu-1)\left(\frac{1}{r}-\frac{1}{r'}\right)=(\mu-1)\frac{1}{r}$$

($r'=\infty$, the lower face of the liquid lens being a plane)

According to sign convention, both f_2 and r are negative. Thus,

$$\mu=1+\frac{r}{f_2} \quad \ldots\ldots\ldots (3)$$

Where μ is the refractive index of the liquid.

Finding r, the radius of curvature of the lower surface of the convex lens i.e. the surface in contact with the liquid, and knowing f_2 from relation (2), the refractive index of the liquid, μ can be found out by using relation (3).

Note: The radius of curvature of the surface of the lens is given by,

$$r=\frac{a^2}{6h}+\frac{h}{2}$$

Apparatus:

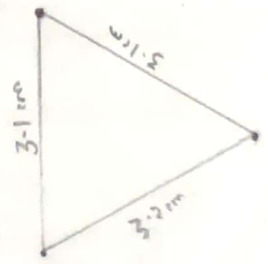
- A convex lens
- A plane mirror
- Pin/pointer with its tip painted
- Spherometer
- Slide calipers
- Stand
- Some experimental liquid (water or glycerin)

Experimental Data:

(A) Measurement of h

Reading on	No. of obs.	LSR,, x (cm.)	CSR	LC (cm.)	Value of CSR, y (cm.)	Total x+y (cm.)	Mean (cm.)
Base plate	1	0	11	$\frac{Pitch}{N} = \frac{0.1}{100}$	0.011	0.011	0.0116
	2	0	14		0.014	0.014	
	3	0	10		0.01	0.01	
Lens surface	1	0.1	86		0.086	0.186	0.168
	2	0.1	56		0.056	0.156	
	3	0.1	62		0.062	0.162	

h = Reading on lens – Reading on the base plate = ~~0.0116~~ (0.168 − 0.0116) = 0.1564 cm



Measurement of 'a': Mean value of a = $\frac{a_1 + a_2 + a_3}{3}$ = 3.133 cm

Therefore, radius of curvature of the spherical surface, $r = \frac{a^2}{6h} + \frac{h}{2}$ = 10.53

$r = \frac{(3.133)^2}{6 \times 0.1564} + \frac{0.1564}{2} = 10.53$ cm

(B) Table for the thickness of convex lens t,

No. of obs.	MSR, x (cm.)	VSR	Vernier Constant, VC (cm.)	Value of VSR, y (cm.)	Total reading, x+y (cm.)	Mean thickness (cm.)	Instru-mental Error	Correct thickness t (cm.)
1	0.7	9	0.005	0.045	0.745	0.74	0	0.74
2	0.7	8	0.005	0.04	0.74			
3	0.7	7	0.005	0.035	0.735			

(C) Determination of the focal lengths

No. of obs.	Distance between the pin and the face of the lens (without the liquid), h_1 (cm.)	Focal length of the convex lens, $f_1 = h_1 + \frac{t}{3}$ (cm.)	Mean f_1 (cm.)	Distance between the pin and the face of the lens (with the liquid), h_2 (cm.)	Focal length of the combination, $F = h_2 + \frac{t}{3}$ (cm.)	Mean F (cm.)	Focal length of the liquid lens, $f_2 = \frac{Ff_1}{F - f_1}$ (cm.)
1	10.1	10.34	10.44	17.8	18.04	17.77	25.31
2	10.2	10.44		17.5	17.74		
3	10.3	10.54		17.3	17.54		

Result:

The refractive index of the liquid is, $\mu = 1 + \frac{r}{f_2} = 1 + \frac{10.53}{25.31} = 1.41$

Discussions: Error $= \frac{1.33 \sim 1.41}{1.33} \times 100\% = + 6.015\%$

Q: What is refractive index? Write down the refractive index of water and compare your result.

Refractive index of a material is a dimensionless number that describes how fast light travels through the material.

The refractive index of water is 1.33

Our result is 1.41

The difference here is 0.08

Thus our error is $\frac{0.08}{1.33} \times 100\% = 6.015\%$

Q: What is the physical significance of refractive index?

The physical significances of ~~reff~~ refractive index are as follows :-

i) Refractive index lets us know the speed of light through an object.

ii) It can possibly be used to measure refraction when light travels from one medium to another.

iii) Such qualities can be used for determining focusing power of lenses, dispersive power of prisms, reflectivity of lens coatings and light guiding nature of optical fiber.

Q: What is the speed of light through the liquid whose refractive index you have determined?

We know,

refractive index, $\mu = \frac{c}{v} \Rightarrow v = \frac{c}{\mu}$

$c = 3 \times 10^8 ms^{-1}$

$\mu = 1.41$

$= \frac{3 \times 10^8}{1.41} = 2.12 \times 10^8 ms^{-1}$

The speed of the light is calculated as $2.12 \times 10^8 ms^{-1}$

Q: What is radius of curvature? Is it possible to find the refractive index of the given liquid without using a spherometer?

The radius of curvature is the radius of a circle that touches ~~the~~ a curve at a given point that has the same tangent and curvature at that point.

There are other ways to find refractive index of liquid, namely Abbe refractometer and pulfrich refractometer.

A refractometer is a device that measures to which extent light is bent when it moves from air to sample. Thus, a spherometer is not required if we use a refractometer to measure the refractive index of the given liquid.

Q: Calculate the Least Count of the given spherometer.

least count $= \frac{\text{pitch}}{\text{no. of divisions of circular scale}}$

pitch = 1 mm = 0.1 cm

no. of divisions of circular scale = 100

$= \frac{0.1}{100} = 0.001 cm$

United International University

Name: Saleheen Siddique ID: 011211057

Section: G Group: 4 Date: ~~Spring 2022~~ 24/04/22

Experiment No. 02

Name of the Experiment: Determination of the value of the Acceleration due to Gravity (g) with the help of a compound (bar) pendulum.

Theory:

Compound pendulum is a rigid body of any shape free to turn about a horizontal axis. (See figure)

The time period (T) of a compound pendulum is given by,

$$T = 2\pi\sqrt{\frac{K^2 + l^2}{gl}} \quad \ldots\ldots\ldots (1)$$

where,
l = the distance of the point of suspension from the center of gravity,
K = Radius of gyration of the pendulum about an axis passing through the Center of Gravity (C.G.)

Since the periodic time of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$, the period of the rigid body (compound pendulum) is the same as that of a simple pendulum of length,

$$L = \frac{l^2 + K^2}{l} = l + \frac{K^2}{l} \quad \ldots\ldots\ldots (2)$$

This length (L) is known as the length of the *Simple Equivalent Pendulum*. The expression for L can be written as a quadratic in l. Thus from equation (2),

$$l^2 - lL + K^2 = 0 \ldots\ldots\ldots (3)$$

By solving the above equation, the two distinct roots obtained will be l_1 and l_2 for which the body has equal times of vibration. From the theory of quadratic equations,

$$l_1 + l_2 = L \text{ and } l_1 l_2 = K^2$$

As the sum and the products of two roots are positive, the two roots are both positive. This means that there are two positions of the center of suspension on the same side of C.G. about which the periods (T) would be the same. On the other side of the C.G., similarly there will be two more points of suspension, about which the time periods (T) will again be the same. Thus, there are altogether *four* points, *two* on either side of the C.G., about which the time periods of the pendulum are the same (T). The distance between two such points, asymmetrically situated on either side of the C.G., will be the length (L) of the simple equivalent pendulum. If the period of oscillation about these points are T, then from the expression, $T = 2\pi\sqrt{\frac{L}{g}}$, we get,

$$g = 4\pi^2 \frac{L}{T^2} \ldots\ldots\ldots (4)$$

By finding L graphically, and determining the value of the period T, the acceleration due to gravity (g) at the place of the experiment, can be measured.

Apparatus:

- Bar pendulum
- Meter scale
- Stop watch

Experimental Data:

(A) Determination of the Period (T) and Distance (d) of the knife-edge from one fixed end

At the top	Hole no.	Distance of the point of suspension from the center of gravity, l (cm.)	Time of 10 oscillations (sec.)	Mean time taken (sec.)	Time period T (sec.)
On one side of C.G.	1	10	19.14 19.51	19.32	1.932
	2	20	15.90 16.40	16.15	1.615
	3	30	15.21 15.43	15.32	1.532
	4	40	15.71 15.90	15.805	1.58
On other side of C.G.	1	10	19.19 19.41	19.3	1.93
	2	20	15.63 15.75	15.69	1.569
	3	30	15.07 15.37	15.22	1.522
	4	40	15.49 15.38	15.435	1.543

(B) Determination of the value of 'g' from graph

No. of Obs.	Length AC (cm.)	Length BD (cm.)	Length of Eq. Simple Pendulum, $L=\frac{AC+BD}{2}$ (cm.)	Corresponding value of time period (T) from graph (sec.)	$g=4\pi^2\frac{L}{T^2}$ (cm./sec.^{2})	Mean value of g (cm./sec.^{2})
1	66	58	63	1.55	1018.8	1007.54
2	68	58	63	1.58	996.29	
3						

Calculation:

$$g_1 = 4\pi^2\frac{L}{T^2} = 4\times\pi^2\times\frac{62}{1.55^2} = 1018.80 \text{ cm/sec}^2$$

$$g_2 = 4\pi^2\frac{L}{T^2} = 4\times\pi^2\times\frac{63}{1.58^2} = 996.20 \text{ cm/sec}^2$$

$$g_3 = 4\pi^2\frac{L}{T^2} =$$

Therefore, $g =$ 1007.54 cm/sec^2

$$\text{Error} = \frac{980 \sim 1007.54}{980}\times 100\%$$
$$= 2.81\%$$

Result:
The acceleration due to gravity is, $g =$ 1007.54 cm/sec^2

Discussions:

Q: What is acceleration due to gravity? What is the physical significance of acceleration due to gravity?

The acceleration of a body in free fall under the influence of earth's gravity expressed as the rate of increase of velocity per unit time and the value is 980.665 cm/sec^2 (appx)

This is significant in physics because gravity applies to every single material on earth and thus the acceleration due to gravity is significant in wide range of motion based calculations

Q: What are center of suspension and center of oscillation of a compound pendulum? What is simple equivalent length?

Center of suspension:- the point about which a pendulum rotates.

Center of Oscillation:- A point on the line passing through the pendulum's center of mass and perpendicular to the axis of rotation.

Simple equivalent length:- The distance from the pivot to the center of oscillation.

Q: If a body is released from the roof top of UIU which is 25m above from the earth surface, calculate the time required for the body to touch the ground with g you have found in this experiment.

g in the experiment $= 1007.54\ cm/sec^2$

$= 10.0754\ m/s^2$

we need to find the time required for the body to tough the ground. we have, $g = 10.0754$ we know, $h = ut + \frac{1}{2}gt^2$

$h = \frac{1}{2}gt^2$

~~$\frac{d}{t^2} = 10.0754$~~

~~$t = \sqrt{\frac{d}{10.0754}} = \sqrt{\frac{25}{10.0754}} = 1.57\ sec$~~

$t = \sqrt{\frac{2h}{g}} = 2.227\ sec$

$\left(\sqrt{\frac{25 \times 2}{10.0754}}\right) = 2.227\ sec$

Q: What are the advantages of Compound Pendulum over Simple Pendulum?

The advantages are as follows:-

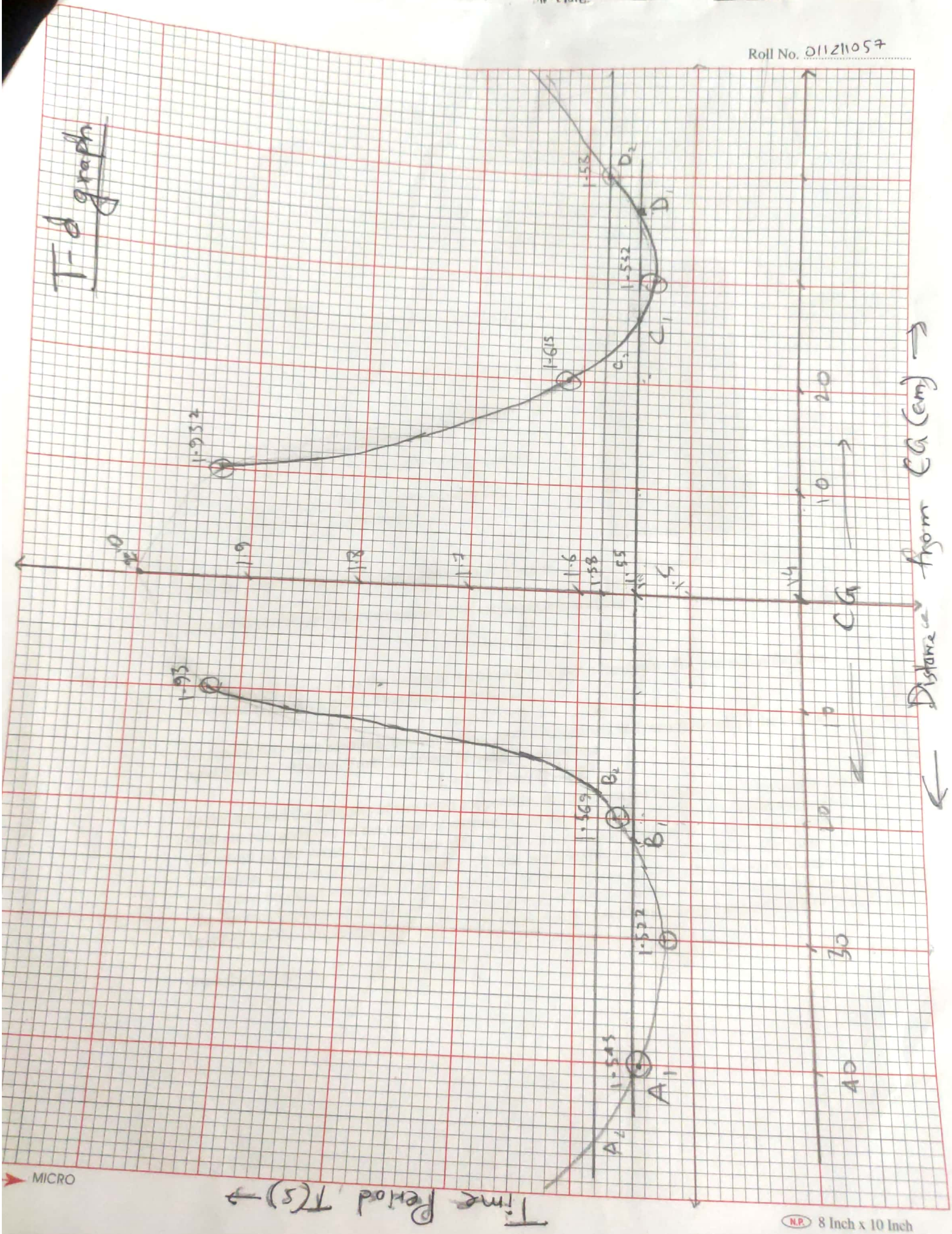
i) The period and the frequency of compound pendulum depend on the length of gyration, moment of inertia, and the mass of pendulum as well as gravitational acceleration (g), for simple pendulum it is only the length of string and g that affects these parameter.

ii) Simple pendulum is an idealized system that is not practical. On the other hand, compound pendulum does not have impractical ideal conditions, thus can give more accurate results.

Teacher's Signature:

Date:

Roll No. 01121057



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Name: Saleheen Siddique ID: 011211057

Section: G Batch: 211 Date: 16/05/21

Experiment No. 04

Name of the Experiment: Determination of the frequency of a tuning fork by Melde's apparatus.

Theory:

When a tuning fork is excited and held near a stretched string, transverse vibrations are propagated along the string with a velocity,

$$v = \sqrt{\frac{T}{m}}$$

Where, T is the tension of the string and m is its mass per unit length. If the plane of vibration of the fork is perpendicular to the string, the frequency of vibration of the string is equal to that of the fork, while if they are parallel, the frequency is half that of the fork. The wavelength is therefore $\lambda = \frac{v}{f}$ for perpendicular vibrations and $\lambda = \frac{2v}{f}$ for parallel vibrations, where f represents the frequency of the fork.

For a given tension T, if the length of the string is properly adjusted so as to make its total length equal to an integral multiple of $\lambda/2$, then the stationary wave pattern will be formed. If l be the length of a single loop (distance between successive nodes), then when the fork vibrates perpendicular to the string, the value of l is given by the relation,

$$l = \frac{\lambda}{2} = \frac{v}{2f} = \frac{1}{2f}\sqrt{\frac{T}{m}}$$

$$\therefore f = \frac{1}{2l}\sqrt{\frac{T}{m}}$$

When the fork vibrates parallel to the string, then

$$f = \frac{2}{2l}\sqrt{\frac{T}{m}} = \frac{1}{l}\sqrt{\frac{T}{m}}$$

If a load of W is applied to the string to keep it tight and M_p is the mass of the scale pan, then the total load applied is $M = W + M_p$ and the tension of the string is $T = Mg$ dynes.

Hence the 2 equations become,

$$f = \frac{1}{2l}\sqrt{\frac{Mg}{m}}, \text{ for perpendicular vibration}$$

$$f = \frac{1}{l}\sqrt{\frac{Mg}{m}}, \text{ for parallel vibration}$$

CamScanner

- Wooden clamps

Experimental Data:

(A) Mass of the scale pan, M_p = 31.20 gm

(B) Length of the sample thread, L = 195 cm

Mass of the sample thread, M = 0.62 gm

Thus, mass per unit length of the thread, $m = \frac{M}{L} = 3.17\times10^{-3}$ gm cm^{-1}

(C) Longitudinal position

No. of obs.	Load on the scale pan, W (gm.)	Tension, $T = Mg = (W + M_p)g$ (dynes)	Distance between the pins, G (cm.)	No. of loops between the pins, N	Length of a segment, $l = G/N$ (cm.)	$f = \frac{1}{l}\sqrt{\frac{T}{m}}$ (Hz.)	Mean f (Hz.)
1	0	30576	157	2	78.5	39.56	
2	10	40376	94	1	94	37.96	38.23
3	20	50176	107	1	107	37.18	

(D) Transverse position

No. of obs.	Load on the scale pan, W (gm.)	Tension, $T = Mg = (W + M_p)g$ (dynes)	Distance between the pins, G (cm.)	No. of loops between the pins, N	Length of a segment, $l = G/N$ (cm.)	$f = \frac{1}{2l}\sqrt{\frac{T}{m}}$ (Hz.)	Mean f (Hz.)
1	0	30576	135	3	45.0	34.50	
2	10	40376	100	2	50.0	35.68	36.39
3	20	50176	102	2	51.0	39.00	

Calculation:

For Longitudinal position: 38.23 Hz

$$f_{1L} = \frac{1}{l_1}\sqrt{\frac{T_1}{m}} = \frac{1}{78.5}\sqrt{\frac{30576}{3.17\times10^{-3}}} = 39.56 \text{ (Hz)}$$

$$f_{2L} = \frac{1}{l_2}\sqrt{\frac{T_2}{m}} = \frac{1}{94}\sqrt{\frac{40376}{3.17\times10^{-3}}} = 37.96 \text{ (Hz)}$$

$$f_{3L} = \frac{1}{l_3}\sqrt{\frac{T_3}{m}} = \frac{1}{107}\sqrt{\frac{50176}{3.17\times10^{-3}}} = 37.18 \text{ (Hz)}$$

$$\therefore \text{mean } f_L = \frac{39.56+37.96+37.18}{3} = 38.23 \text{ (Hz)}$$

For Transverse position: 36.39 Hz

$$f_{1T} = \frac{1}{2l_1}\sqrt{\frac{T_1}{m}} = \frac{1}{2\times45}\sqrt{\frac{30576}{3.17\times10^{-3}}} = 34.50$$

$$f_{2T} = \frac{1}{2l_2}\sqrt{\frac{T_2}{m}} = \frac{1}{50\times2}\sqrt{\frac{40376}{3.17\times10^{-3}}} = 35.68$$

$$f_{3T} = \frac{1}{2l_3}\sqrt{\frac{T_3}{m}} = \frac{1}{51\times2}\sqrt{\frac{50176}{3.17\times10^{-3}}} = 39.00$$

$$\text{mean, } f_T = \frac{34.50+35.68+39.00}{3} = 36.39 \text{ Hz}$$

Result:

The frequency of the tuning fork is, $f = \frac{f_L+f_T}{2}$

$$f = \frac{38.23+36.39}{2} = 37.31 \text{ Hz}$$

(Ans)

16.05.'22

Discussions:

Q: What is traveling wave and standing wave? How does standing wave differ from traveling waves? Traveling wave is the wave in which the particles of the medium move progressively in the direction of the wave.

Standing wave is also called stationery wave, it is the combination of two waves moving in opposite directions, each having the same amplitude and frequency. Their differences are as follows:-

Standing waves differ from traveling waves because they only occur for certain frequencies.

Travelling

Q: In this experiment why it is necessary to observe that resonance have occurred?

Melde's experiement is done to study the behavior of standing waves. Standing waves can only occur for certain frequencies. Now it is required in the experiment as two frequencies will have to be identical. But a variation of frequency occurs if the resonance is not observed properly.

Q: Why the length of the string between the pulley and the scale pan should be kept short?

The length of string between pulley and scale pen is kept short otherwise the actual weight will be larger than the applied weight due to weight of the string and spring needs to have minimal effect.

Q: Why is it necessary to consider the mass of the scale pan?

Scale pan has a non-negligible mass in melde's experiment. This scale pan also adds to the tension created in the spring that adds to the calculation in the experiment.

Q: Draw the amplitude ~ frequency curve of a driven system in a low damping medium, in a high damping medium and in a medium where there is no damping?

Q: How do you know that a resonance has occurred between the fork and the string?

Resonance between fork and string can be known if a certain frequency is obtained which matches the resonant frequency, then the experiment will show wave pattern in the string.

Thus, the fork, when having equal ~~zero frequency~~ as the resonant frequency of the string, will show such nature.

19/20

Name: Saleheen Siddique ID: 011211057

Section: G Group: 4 Date: 6-2-22

Experiment No. 05

Name of the Experiment: Determination of the spring constant and effective mass of a given spiral spring.

Theory:

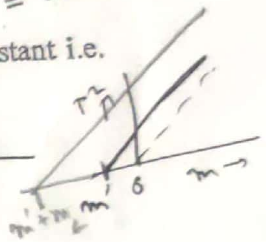
If a spring is clamped vertically at the end P, and loaded with a mass m_0 at the other end A, then the period of vibration of the spring along a vertical line is given by,

$$T = 2\pi\sqrt{\frac{m' + m_0}{k}} = 2\pi\sqrt{\frac{M}{k}} \;\ldots\ldots\ldots (1)$$

$T^2 \propto m$

$T^2 = \text{const.}\, m$

Where, m' is a constant called the effective mass of the spring and k, the spring constant i.e. the ratio between the added force and the corresponding stretch of the spring.



The contribution of the mass of the spring to the effective mass of the vibrating system can be shown as follows: Consider the kinetic energy of a spring and its load undergoing simple harmonic motion. At the instant under consideration, let the load m_0 be moving with velocity v_0 as shown in the figure.

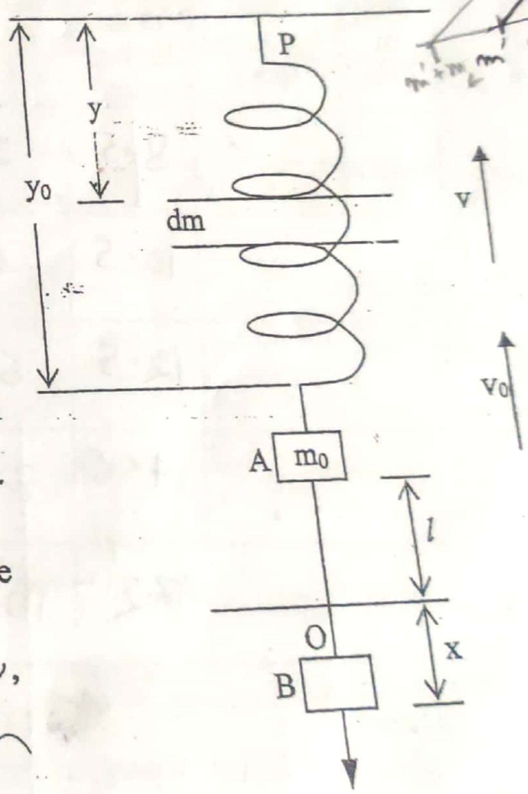


Fig. 01

At the same instant, an element dm of the mass m of the spring will also be moving up but with a velocity v which is smaller than v_0. It is evident that the ratio between v and v_0 is just the ratio between y and y_0. Hence, $\frac{v}{y} = \frac{v_0}{y_0}$ i.e.

$v = \frac{v_0}{y_0}y$. The kinetic energy of the spring alone will be $\int \frac{v^2}{2}dm$. But dm maybe written as $\frac{m}{y_0}dy$, where, m is the mass of the spring.

Thus the integral equals to $\frac{1}{2}\left(\frac{m}{3}\right)v_0^2$. The total kinetic energy of the system will then be $\frac{1}{2}\left(m_0 + \frac{m}{3}\right)v_0^2$ and the total mass of the system is therefore, $M = \left(m_0 + \frac{m}{3}\right)$

$F = |kl|$

$mg = kl$

$k = \frac{g}{l/m} = \frac{g}{dl/dm}$

Hence, effective mass, $m' = \frac{m}{3}$. The applied force m_0g is proportional to the extension l within the elastic limit.

Therefore, $k = \frac{F}{l} = \frac{m_0 g}{l}$

$m_0g = kl$ or, $l = \frac{g}{k} m_0$

$$k = \frac{g}{l/m_0} = \frac{g}{\text{slope of l vs } m_0 \text{ graph}} = \frac{980}{dl/dm}$$

Apparatus:

- A spiral spring
- Convenient masses with hanging arrangement
- Clamp or a hook attached to a rigid framework of heavy metal rods
- Weighing balance
- Stopwatch and scale

Experimental Data:

(A) Initial length of the Spring, L_0 = 6.5 cm ; m_L = 100 gm

(B) Table for determining extensions and time periods:

No. of Obs.	Added Loads, m_0 (gm.)	Length of the Spring, L (cm)	Extension, $l = L - L_0$ (cm.)	No. of vibrations	Total time (sec.)	Period, T (sec.)	T^2 (Sec^2)
1	50	8.5	2	10	5.02	0.502	0.252
2	100	10.5	4	10	5.88	0.588	0.345
3	150	12.5	6	10	6.10	0.61	0.372
4	200	14.6	8.1	10	6.65	0.665	0.442
5	250	17.2	10.7	10	7.15	0.715	0.511

Calculation:

(A) 1. Effective mass, m′ (from graph) = 125 gm

2. Effective mass of the spiral spring (M/3) = $\frac{30}{3} + m_L = \left(\frac{30}{3} + 100\right)$ gm = 110

3. Difference (%) = $\frac{110 \sim 125}{110} \times 100\%$ = 13.63 %

Q: How do you k...

(B) Spring Constant $k = \frac{g}{\text{slope of } l \text{ vs } m_o \text{ graph}}$

$= \frac{980}{0.042}$

$= 23333.33$ dynes/cm

Slope of l vs m_0 graph $= l/m_0$

$= 0.042$

Results:

(A) Value of the Effective Mass, $m' =$ 125 gm

(B) Value of the Spring Constant, $k =$ 23333.33 ~~gm~~ dynes/cm dynes/cm

6.3.2024

Discussions:

Q: What do you understand by the term *Spring Constant*?

Spring constant can be got from Hooke's law. It is a measure of stiffness of a spring. It is denoted by k. The value of k refers to the force needed to stretch or press a spring divided by the distance that the spring gets stretched or compressed. That is,

$$F = -\frac{F_s}{x} \quad \Big| \quad F_s = \text{spring force}, \ x = \text{spring stretch/compression}$$

Q: What is the *Effective Mass* of a spring?

In case of spring mass system, spring has a non negligible mass that needs to be considered. But when spring moves as with the entire mass M, the value of spring's original mass can't be considered as not all of spring's length move at the same. Considering this scenario, $\frac{1}{3}$ th of the mass of the spring is considered to be the effective mass of the spring. This is independent on the direction of the system.

Q: Calculate the extension of your spring when a load of 300 gm is used from the l vs m_0 curve.

From the l vs m_o curve, the extension of the spring is calculated as 12 cm ~~(when corrected)~~

Where?

Q: Does the time period of oscillation depends on the displacement from the equilibrium position? Explain

The time period of oscillation does not depend on the displacement from the equilibrium position. It depends on the mass and the spring constant. Because,

$T = 2\pi\sqrt{\frac{m}{k}}$ | where T = time period, m = mass, k = sping constant.

Q: What happens to the time period if you keep increasing the load?

In this experiment the time period kept increasing as the load kept increasing. As we have $T = 2\pi\sqrt{\frac{m}{k}}$ we have.

$m \propto T^2$; mass is proportional to square of time period

Thus increasing load will increase the time period as these factors are proportional.

Q: What type of motion does the spring-block system have? Write the differential equation for such motion. Write the solution of the differential equation.

Spring block system has the Simple harmonic motion

we know from Newton's 2nd law of motion,

$F = -kx$

$\Rightarrow ma = -kx$

$m\frac{d^2x}{dt^2} = -kx$

$m\frac{d^2x}{dt^2} = -kx$

$\Rightarrow \frac{d^2x}{dt^2} + \frac{kx}{m} = 0$

$\Rightarrow \frac{d^2x}{dt^2} + \omega^2 x = 0$ as $\omega^2 = \frac{k}{m}$

(Solved)

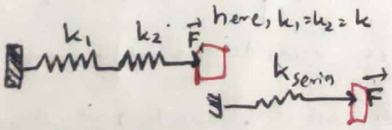
Sol^n : $x = A\sin(\omega t + \delta)$

$A = ?$, $\omega = ?$ . .

Q: Suppose two springs with the same spring constant k. Draw the diagram, when these two springs are in (i) series and (ii) parallel combination. Show that the equivalent spring constant (i) $k_{series} = \frac{k}{2}$ and (ii) $k_{parallel} = 2k$.

For series, the diagram

here, $k_1 = k_2 = k$



we have for this,

For spring 1. $F = k_1 x_1$, $x_1 = \frac{F}{k_1}$

For spring 2 $F = k_2 x_2$, $x_2 = \frac{F}{k_2}$

Total deformation.

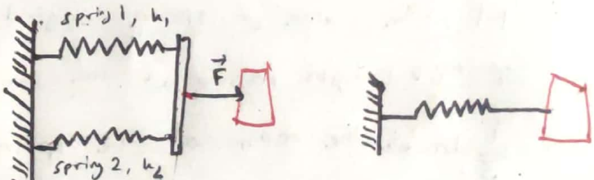
$x_1 + x_2 = \frac{F}{k_1} + \frac{F}{k_2} = F\left(\frac{1}{k_1} + \frac{1}{k_2}\right)$

We have,

$\therefore \frac{F}{x_1 + x_2} = k_{series} = \left(\frac{1}{k_1} + \frac{1}{k_2}\right)^{-1}$

$= \left(\frac{1}{2k}\right)^{-1} = 2k$ [As $k_1 = k_2 = k$]

For parallel, the diagram.



Here, the system of two parallel springs is equal to ~~—~~ single spring ~~according~~

thus,

$k = k_1 + k_2$

$\therefore k_{parallel} = 2k$

[Showed]

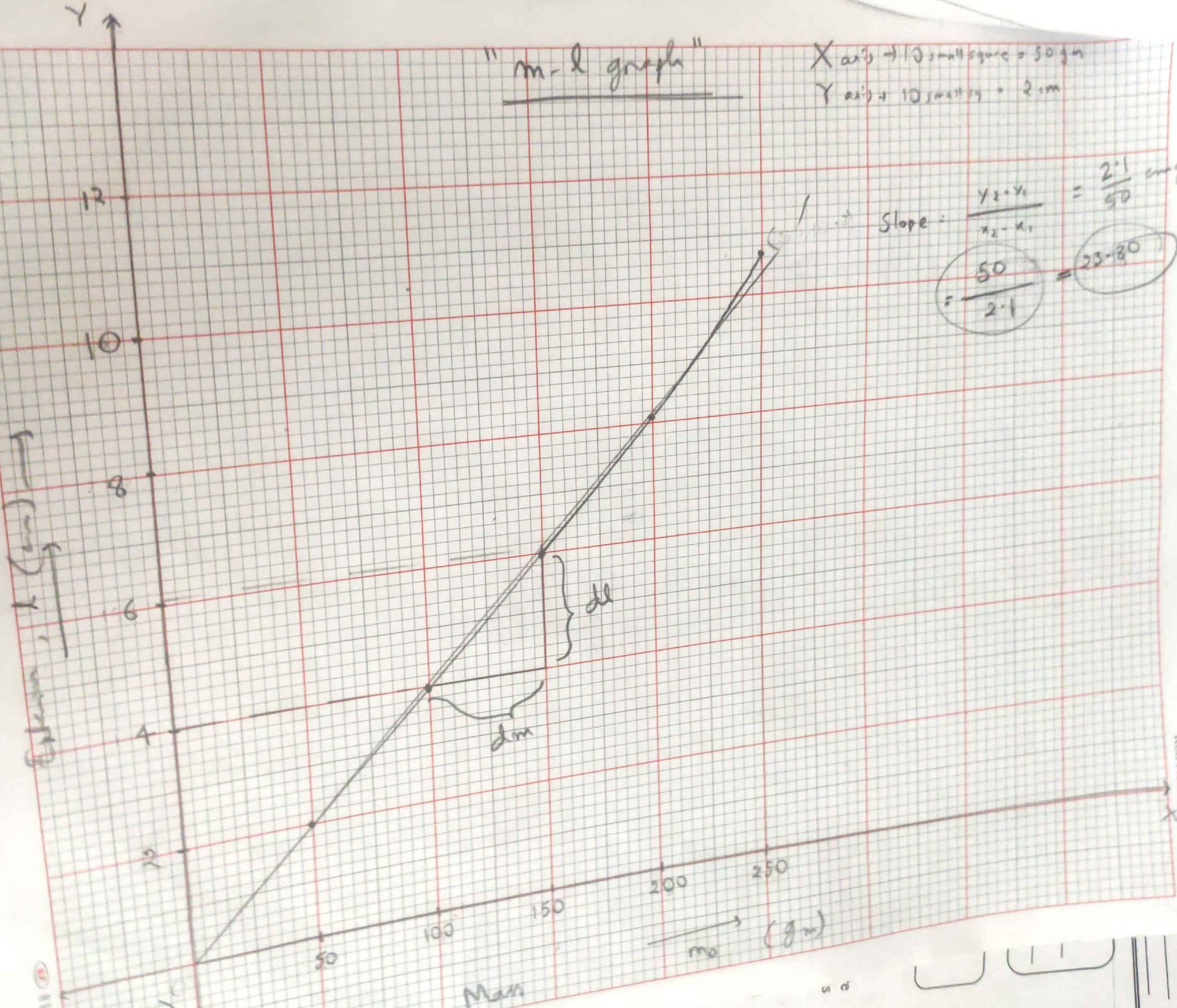
| $k_1 = k_2 = k$

"m-l graph"

X axis → 10 small square = 50 gm
Y axis → 10 small sq = 2 cm

Slope $= \frac{y_2 - y_1}{x_2 - x_1} = \frac{2.1}{50}$ cm gm^{-1}

$= \frac{50}{2.1} = 23.80$



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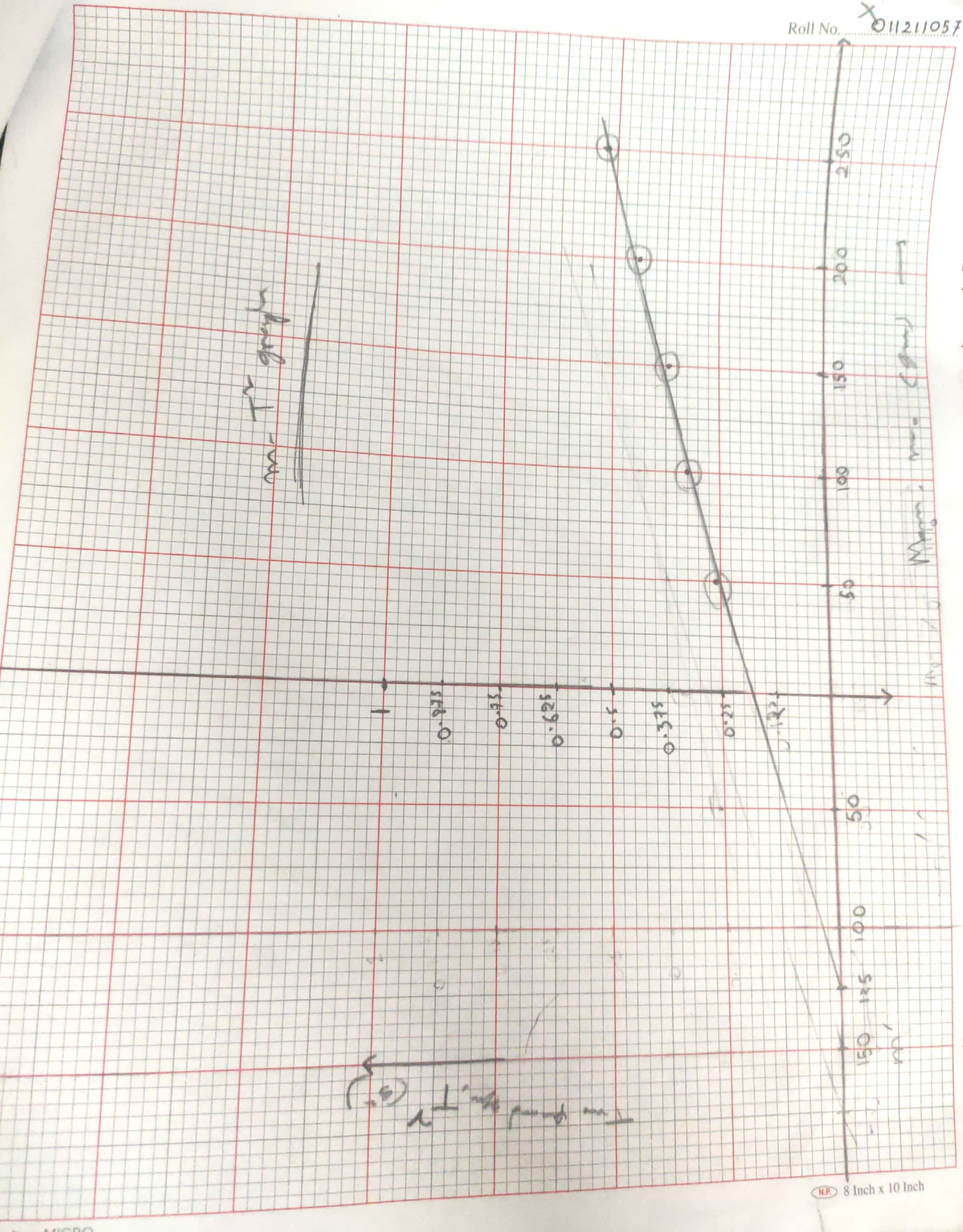

8 Inch x 10 Inch

MICRO

Teacher's Signature:__________
Date: __________

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United International University

Name: Saleheen Siddique ID: 011211057
Section: C Group: 4 Date: 13/03/22

Experiment No. 06

Name of the Experiment: Determination of the Young's modulus of the material of a wire by Searle's dynamic method.

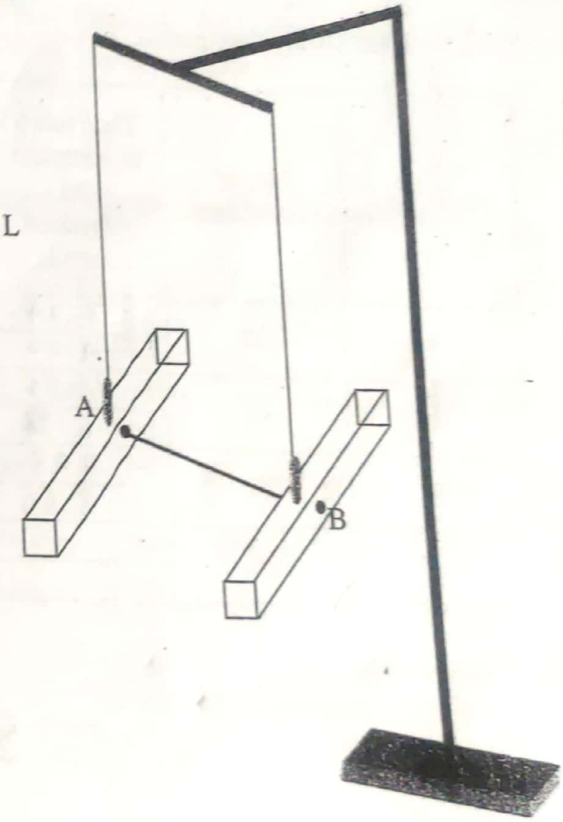
Theory:

If a wire specimen is fastened to two identical bars at their mid-points from which they are supported by threads and if the ends of the bars are drawn together and released, the bars oscillate with a period T. In that case, Young's modulus is given by the formula, $Y = \frac{8\pi I}{T^2 r^4} l$

Where l is the length and r is the radius of the wire. I is the moment of inertia of one of the bars about its supporting thread.

Note: For a rectangular object having mass M, length L and width b, the moment of inertia is given as,

$$I = \frac{M}{12}(L^2 + b^2)$$



Apparatus:

- Searle's apparatus
- Screw gauge
- Stopwatch
- Slide calipers
- Meter scale etc.

Experimental Data:

(A) Table for the width of a bar, b

No. of obs.	MSR, x (cm.)	VSR	Vernier Constant (cm.)	Value of VSR, y (cm.)	Total reading, x+y (cm.)	Mean Width (cm.)	Instrumental error	Correct width, b (cm.)
1	0.7	2	0.005	0.01	0.701	0.7015	0	0.7015
2	0.7	1		0.005	0.7005			
3	0.7	6		0.03	0.703			

(B) Table for the moment of inertia of the bar, I

Length of the bar, L (cm)	Mass of one bar, M (gm)	Moment of Inertia of one bar, $I = \frac{M}{12}[L^2 + b^2]$ (gm-cm^2)
30.8	145 gm	11246.46

(C) Length of the wire = 27.5 [the horizontal wire AB in figure 1]

(D) Table for the radius of the wire, r

No. of obs.	LSR, x (cm.)	CSR	Least Count (cm.)	Value of CSR, y (cm.)	Total reading, x+y (cm.)	Mean Diameter (cm.)	Instrumental error	Correct diameter (cm.)	Radius, r = D/2 (cm.)
1	0.15	11	0.001	0.011	0.161	0.1626	0	0.1626	0.081
2	0.15	15		0.015	0.165				
3	0.15	12		0.012	0.162				

(E) Table for the time period, T

No. of obs.	No. of vibrations	Time taken to complete the vibrations (sec.)	Total time taken to complete the vibrations $t = \frac{t_1 + t_2}{2}$ (sec.)	Period of oscillation, T (sec.)	Mean T (sec.)
1	✓ 10	t_1= 3.74	3.87	0.387	0.420
		t_2= 4.00			
2	✓ 15	t_1= 6.55	6.76	0.450	
		t_2= 6.97			
3	✓ 20	t_1= 8.28	8.47	0.423	
		t_2= 8.66			
4	25	t_1=			
		t_2=			

Calculation:

The Young's modulus of the wire is,

$$Y = \frac{8\pi I}{T^2 r^4} l = \frac{8 \times \pi \times 11246.46}{(0.42)^2 \times (0.081)^4} \times 27.5$$

$$= 1.023 \times 10^{12} \text{ Dyne/cm}^2$$

Result:

The Young's modulus of the wire is, Y = 1.023×10^{12} dynes/cm^2

13.3.2022

Discussions:

Q: What is stress and strain? Define longitudinal stress and longitudinal strain. How are they related to Young's Modulus? Derive the unit of Young's Modulus.

Stress: Force per unit area within materials that arise from various external source that can predict elastic, plastic and fluid behavior.

Strain: The amount of deformation experienced by the body in the direction of force applied, divided by the initial dimensions of the body.

Longitudinal Stress :- Stress developed in any object along the length of object when perpendicular force is applied on cross sectional area.

Longitudinal Strain :- Strain developed along the length of object due to longitudinal stress

Related to Young's modulus :- Young's modulus is defined as the ratio of tensile stress to tensile strain (which is one kind of longitudinal stress and strain)

Unit derivation, $Y = \frac{\text{Stress}}{\text{Strain}} = \frac{\text{Force/Area}}{\left(\frac{\text{Change in length}}{\text{original length}}\right)} = N/m^2$

Q: In determining the Young's Modulus of the wire using the formula given which quantities you think should be measured with caution and why?

The given formula here is $Y = \frac{8\pi I}{T^2 r^4} l$

In this calculation, the time period and the radius of the wire should be measured with caution as it is comparatively difficult to obtain the exact values of those parameters.

Again in the formula the degrees are of 2 and 4 for T and r respectively, a small error can drastically change the real value and thus, an accurate measurement is hampered.

Q: On what factors does the value of Y depend?

Young's modulus Y is the ratio of stress and strain. It depends on the following factors:-

i) The nature of the material

ii) Temperature and Pressure

iii) For this experiment, $Y = \frac{8\pi I}{T^2 r^4} l$, so all of these parameters are what Y depends on.

Q: Suppose, you are provided with two wires both made of copper but they are of different length and diameter. What do you think about their Young's Modulus? Will they be different or same? Why?

Young's Modulus is a constant that has the value $\frac{\text{Stress}}{\text{Strain}}$. It is a material's property and therefore does not depend on length on diameter. So, the young's Modulus will be same for both the wires.

Q: Is it possible to determine the *Rigidity Modulus* of elasticity using this apparatus? Explain.

Rigidity Modulus is the measure of rigidity of the body. given by the ratio of Shear stress to shear strain. The formulae is also almost the same. $\eta = \frac{8\pi I}{T^2 r^4} l$ but here the time period has to be got differently. As this is about ~~sho~~ $\frac{\text{Shear stress}}{\text{Shear strain}}$ we have to set up the apparatus differently.

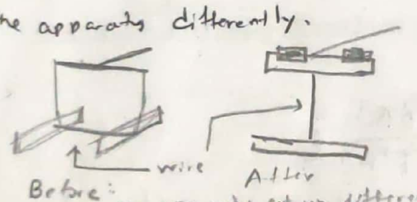


Fig: Apparatus set up differently.

If we set up the wire in a direction perpendicular to the original set up and clamp one end of metal bar and calculate the time period of that, we can get the modulus of rigidity there.

Q: Why have we used a short length wire in the experiment?

A Short wire complements the Seartle's method apparatus which is designed to be ~~user friendly~~ able to distribute the stress more evenly.

- Short wires can distribute stress more evenly, giving more accurate representation in case of our calculation

Q: What is the standard value of the *Young's Modulus* of the material used to perform the experiment?

The material used in this experiment is steel. It's standard Young's modulus value is ~~2×10^5 N/mm^2~~ / 1.9×10^{12} dyne/cm^2

Physics Laboratory

Teacher's Signature: ______

Date: ______

United International University

Name: Sa'cheen Siddique ID: 011211057

Section: a Batch: 4 Date: 13/03/22

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Experiment No. 07

Name of the Experiment: Determination of the modulus of rigidity of a wire by the method of oscillations (Dynamic Method).

Theory:

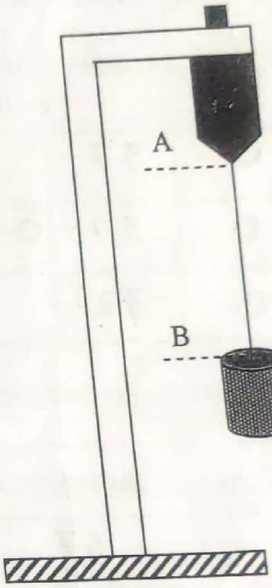

Fig. 01

If a heavy body is supported by a vertical wire of length l and radius r so that the axis of the wire passes through its center of gravity, and if the body is turned through an angle and released, it will execute torsional oscillations about a vertical axis. If, at any instant, the angle of twist is θ, the moment of the torsional couple exerted by the wire will be,

$$\frac{n\pi r^4}{2l\theta} = C\theta \quad \dots\dots\dots (1)$$

Where, $\frac{n\pi r^4}{2l} = C$ is a constant and n is the modulus of rigidity of the material of the wire.

Therefore, the motion is simple harmonic and of fixed period.

$$T = 2\pi\sqrt{\frac{I}{C}} \quad \dots\dots\dots (2)$$

Where, I is the moment of inertia of the body.

From equations (1) and (2), we have,

$$T^2 = \frac{4\pi^2 I}{C} = \frac{8\pi I}{nr^4} l \qquad \text{Or, } n = \frac{8\pi I}{T^2 r^4} l \text{ dynes/cm}^2$$

Note: For a cylindrical object, having mass M and radius a, the moment of inertia is given as,

$$I = \frac{1}{2}Ma^2$$

Apparatus:

- A uniform wire
- A cylindrical bar
- Suitable clamp
- Stopwatch
- Screw gauge
- Vernier scale
- Meter scale etc.

Experimental Data:

(A) Mass of the cylinder, M = 1110 gm

(B) Length of the wire = 75cm

(C) Table for the radius of the cylinder, a

No. of obs.	MSR, x (cm.)	VSR	V.C (cm.)	y = VSR ×V.C (cm.)	Total reading, x+y (cm.)	Mean Diameter (cm.)	Radius, a = D/2 (cm.)
1	4.5	19	0.005	0.095	4.595	4.575	2.2875
2	4.5	12		0.06	4.56		
3	4.5	14		0.07	4.57		

(D) Moment of Inertia of the cylinder, I = $\frac{1}{2}Ma^2$ = 2904.12

(E) Table for the radius of the wire, r

No. of obs.	LSR, x (cm.)	CSR	Least Count (cm.)	Value of CSR, y (cm.)	Total reading, x+y (cm.)	Mean Diameter (cm.)	Instrumental error	Correct diameter (cm.)	Radius, r = D/2 (cm.)
1	0	37	0.001	0.037	0.037	0.373	0	0.373	0.018
2	0	37		0.037	0.037				
3	0	38		0.038	0.038				

(F) Table for the time period, T

No. of obs.	Time for 20 oscillations (10 full oscillation)	Period of oscillation, T (sec.)	Mean T (sec.)
1	67	6.7	6.8
2	68	6.8	
3	69	6.9	

Calculation:

The modulus of rigidity of the wire is, $n = \frac{8\pi I}{T^2 r^4} l = 1.127 \times 10^{12}$ dynes

$$= \frac{8 \times 3.1416 \times 2904.12 \times 75}{6.8^2 \times 0.018^4}$$

$$= 1.127 \times 10^{12}$$

Result:

The modulus of rigidity of the wire is, n = 1.127×10^{12} dynes cm^{-2}

13.3.2022

Discussions:

Q: Define Rigidity Modulus of elasticity. What is the difference between Young's Modulus and Rigidity Modulus?

Rigidity modulus of elasticity is defined as the ratio of shear stress to shear strain of a ~~str~~ material.

The Young's Modulus describes how a material gets deformed when a force is applied at right angles to a surface of an object. On the other hand,

The modulus of rigidity describes how a material gets deformed when a force is applied parallel to a surface of an object.

Q: What type of oscillation did you observe in this experiment? Explain.

Torsional oscillations were observed on vertical axis during this experiment.

It is the angular oscillation, along its axis of rotation. In this experiment the body was horizontally oscillating and satisfying the same definition.

Q: On what factors does the time period of oscillation depend?

The time period of oscillation depends on:-

i) the length of the wire

ii) mass of the oscillating system

iii) Temperature

Q: Does the rigidity change with change in temperature?

Rigidity does change with change in temperature

The rigidity modulus is usually observed to decrease with increasing temperature.

Q: If you now replace the wire that you have used to perform the experiment with a wire of large radius but of the same length and material, how the modulus of rigidity will change? Explain.

The modulus of rigidity η is an inherent property of a material. Therefore,
Any change of radius will not change the modulus of rigidity of the wire whatsoever.

Q: On what factors does the degree accuracy of the result depend?

It is a measure of how close a stated value and its actual value is.
They depend on these 5 factors:-

1) Standard
2) Workpiece
3) Instrument
4) Person
5) Environment

While in our calculation, $\eta = \frac{8\pi I}{T^2 r^4} l$ ~~where~~ we have the degrees of T and r to be 2 and 4 respectively. Slight change of their values drastically changes the degree of accuracy. Thus, the 5 factors affecting the values of T and r would affect the degree of accuracy most.

Q: What is the standard value of the *Rigidity Modulus* of the material used to perform the experiment?

The standard value of Rigidity Modulus of this material is 7.9×10^{11} dynescm^{-2}

011211057
Saleheen Siddique

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Experiment No.	08
Name of the Experiment :	Verification of Ohm's Law.

OBJECTIVE:

To verify the following two equivalent forms of Ohm's Law:

a. Express I as a function of V and R.
b. Express V as a function of I and R.

THEORY:

Ohm's law describes mathematically how voltage 'V', current 'I' and resistance 'R' in a circuit are related. According to this law:

"The current in a circuit is directly proportional to the applied voltage and inversely proportional to the circuit resistance".

Formula for voltage:
For a constant value of R, V is directly proportional to I
i.e. $V = IR$

Formula for current:
For a constant value of V, I is inversely proportional to R
i.e. $I = V/R$

EQUIPMENTS:

- Variable DC power supply -1piece
- Digital multimeter (DMM)/ Analog multimeter-1piece.
- Resistances: 1KΩ, 2.2KΩ, 33KΩ, 4.7KΩ, 5.6KΩ, 10KΩ-1piece each.
- Trainer Board
- Connecting Wires.

CIRCUIT DIAGRAM:

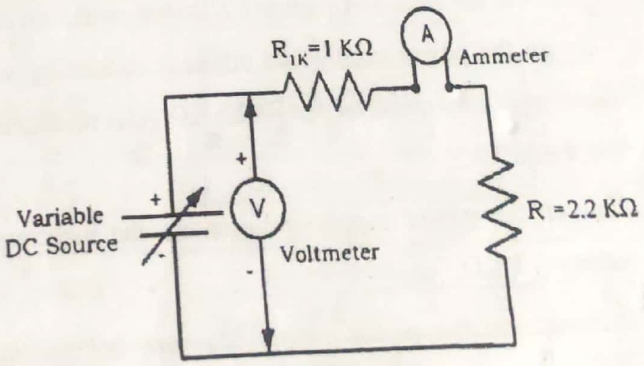


Figure 2.1: Verification of Ohm's Law

DATA SHEET:

Table 2.1: Measuring Resistances by using Ohmmeter

Nominal values of **R (KΩ)**	Measured values of **R(KΩ)** by using Ohmmeter
1	1.03
2.2	2.19
3.3	3.25
4.7	4.63
5.6	5.57
10	9.93

Table 2.2: Current versus voltage

Supply Voltage (V)	Measured I by using Ammeter ~~(A)~~ mA	$R_T = R_{1K\Omega} + R_{2.2K\Omega}$ [Use measured values of R]	Calculate I (amp) $I = V/R_T$	Measured Resistance $R_T = V/I$
5	1.5	3.22	1.55	3.33
10	3	3.22	3.10	3.33
15	4.5	3.22	4.65	3.33
20	6	3.22	6.21	3.33
25	8	3.22	7.76	3.125

Table 2.3: Current versus resistance

Supply Voltage (V)	Measured **I** by using Ammeter **(A)**	R_T (KΩ) Use measured values of R	Calculate $R_T = V/I$ (KΩ)
20	6	$R_T = R_{1K} + R_{2.2K}$ $R_T =$ 3.22	3.33
20	4.67	$R_T = R_{1K} + R_{3.3K}$ $R_T =$ 4.28	4.28
20	3.33	$R_T = R_{1K} + R_{4.7K}$ $R_T =$ 5.66	6.00
20	3.00	$R_T = R_{1K} + R_{5.6K}$ $R_T =$ 6.6	6.66
20	1.67	$R_T = R_{1K} + R_{10K}$ $R_T =$ 10.93	11.97

14.03.2022

Signature of the Teacher

Discussions:

Q: What can you say about the relationship between the voltage and current, provided that the resistance ...

Ohm's law stats, that the current flowing through a conductor is directly proportional to the voltage, given the resistance and temperature to be constant.

Thus we can say, $I \propto V$ when R is fixed.

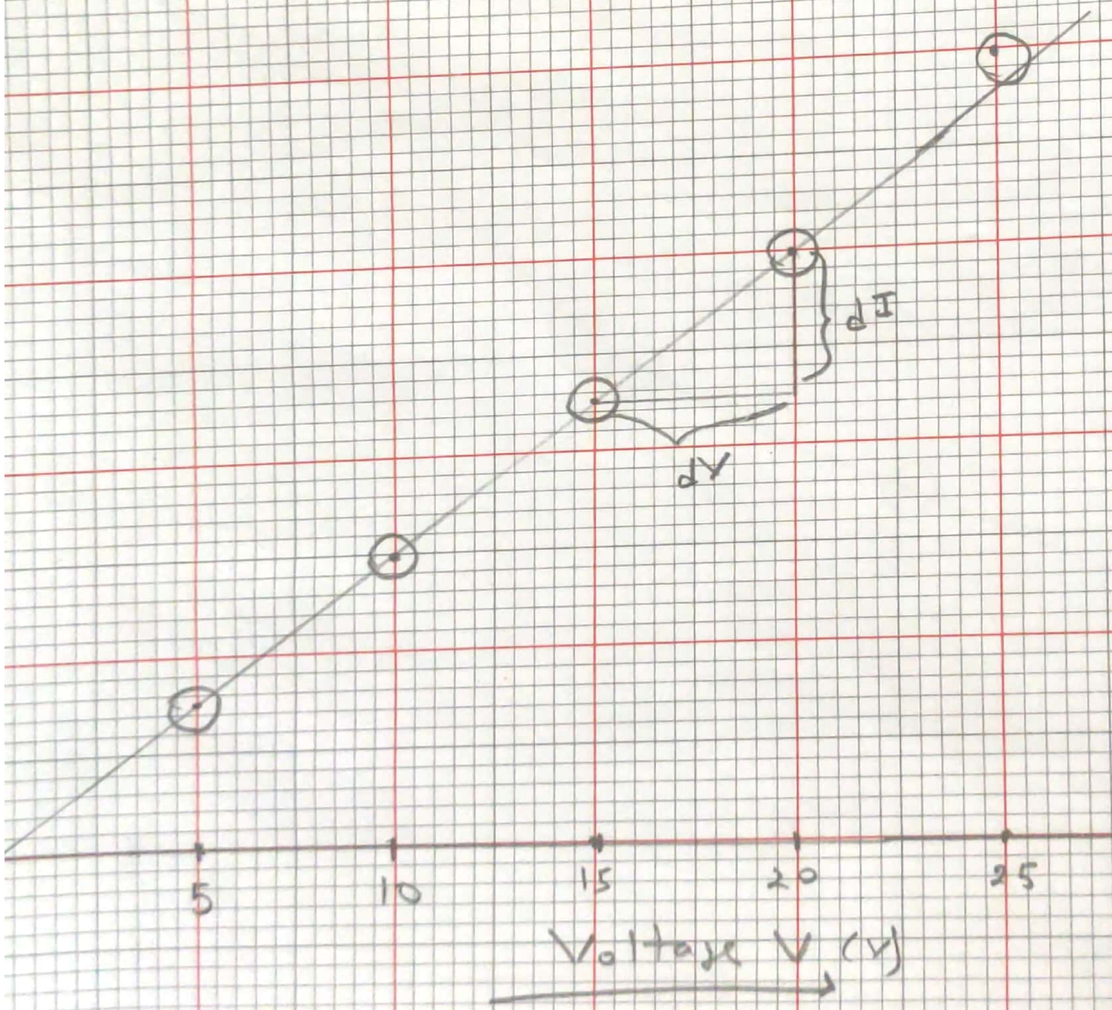
Q: Plot a graph of I versus V keeping the value of resistance constant. Use measured values of I and V. Comment on the graph briefly.

The graph is plotted on the graph paper. The I vs V graph is a graph of straight line that moves along the 1st quadrant. This signifies the proportional relationship of $I \propto V$ and thus this graph can represent that.

Q: Plot a graph of I versus R_T keeping the value of supply voltage constant. Use measured values of I and R_T. Comment on the graph briefly.

The graph of I vs R_T is also drawn on graph paper. In this graph we can see a ~~vertical asymptote at the~~ hyperbola graph that when one value increases, the other decreases uniformly. This signifies an inversely proportional relationship. So, we can claim that, $I \propto \frac{1}{R_T}$ in this case.

I-V Graph



$$Slope = \frac{dI}{dV} = \frac{6 - 4.5}{20 - 15} = 0.3$$

$$R = \frac{1}{0.3}\ k\Omega = 3.33$$

$$Error = \left| \frac{3.22 - 3.33}{3.22} \right| \times 100\%$$

$$= 3.41\%$$

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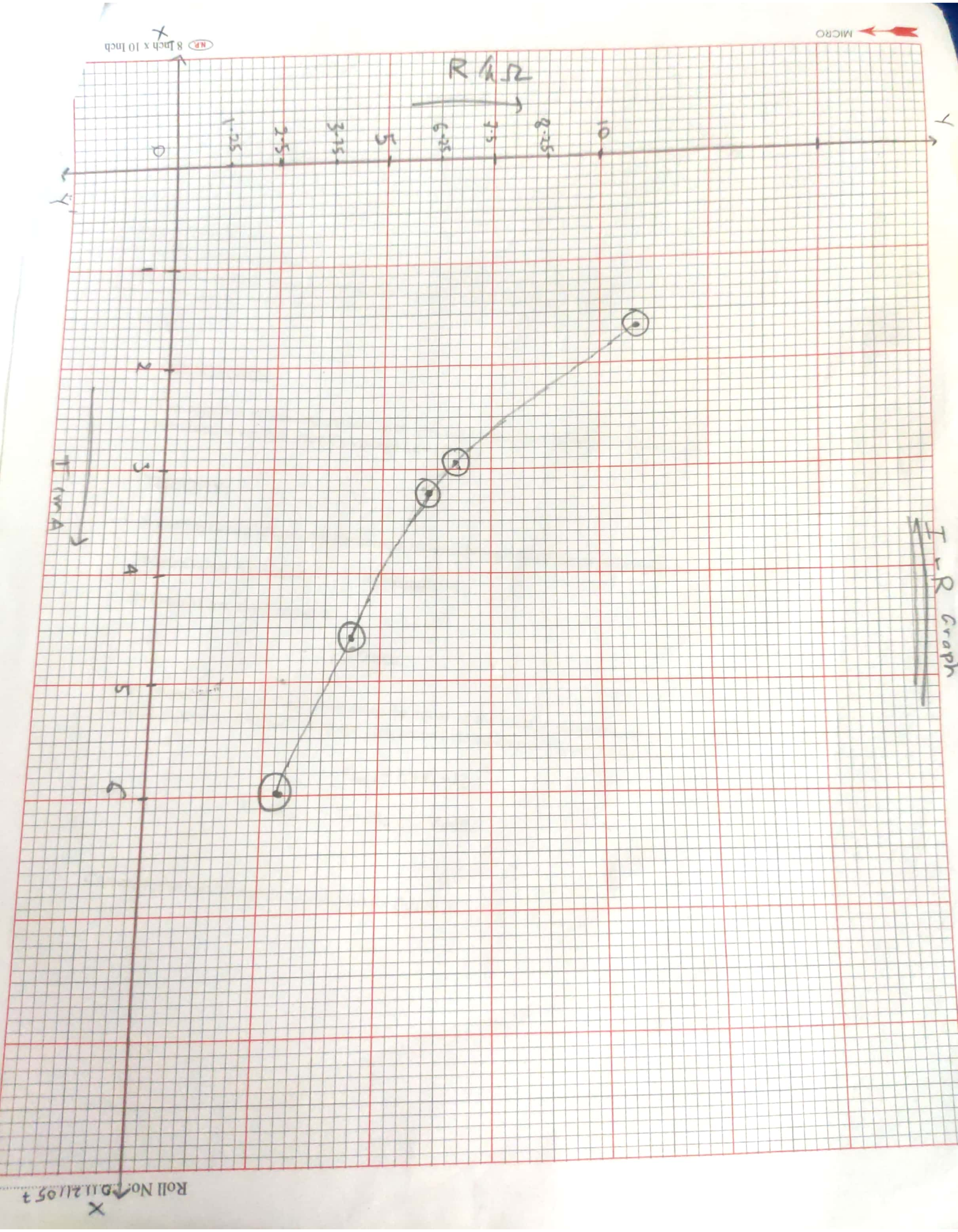


8 Inch x 10 Inch
MICRO
R kΩ
1.25
2.5
3.75
5
6.25
7.5
8.75
10
I mA
1
2
3
4
5
6
I - R Graph
Roll No.

19

Teacher's Signature:________
Date: ________

United International University

Name: Salehan Siddique ID: 011211057

Section: G Group: 4 Trimester: ~~[illegible]~~ Date: 27/03/21

Experiment No. 08

8. a : Name of the Experiment : To investigate the characteristics of a series DC circuit and to verify Kirchoff's Voltage Law (KVL).

OBJECTIVE:

The objective of this experiment is to investigate the characteristics of a series DC circuit and to verify Kirchoff's Voltage Law (KVL).

THEORY:

In a series circuit (Figure 3.1) the current is same through all of the circuit elements.

The equivalent Resistance, $R_T = R_1 + R_2 + R_3$.

By Ohm's Law, the Current is

$$I = \frac{V_{supply}}{R_T}$$

KVL states that the voltage rises must be equal to the voltage drops around a close circuit. Applying Kirchoff's Voltage Law around closed loop of Figure 3.1, we find,

$$V_{Supply} = V_1 + V_2 + V_3$$

Where, $V_1 = IR_1$, $V_2 = IR_2$, $V_3 = IR_3$

Current I is same throughout the circuit for figure 3.1..

CamScanner

...ge divider rule states that the voltage across an element or across a series combination of elements in a series circuit is equal to the resistance of the element divided by total resistance of the series circuit and multiplied by the total impressed voltage. For the elements of Figure 3.1

$$V_3 = \frac{R_3 E}{R_T}$$

$$V_1 = \frac{R_1 E}{R_T},$$

$$V_2 = \frac{R_2 E}{R_T},$$

EQUIPMENTS:

- Variable DC power supply -1piece
- Digital Multimeter (DMM)/ Analog multimeter- 1piece.
- Resistances: 100 Ω, 220 Ω, 470 Ω-1piece each.
- Trainer Board-1piece
- Connecting Wires.

CIRCUIT DIAGRAM:

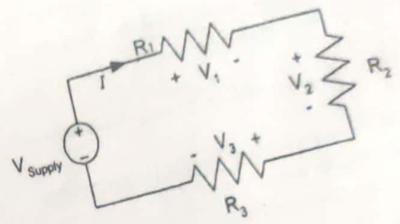


Figure 3.1

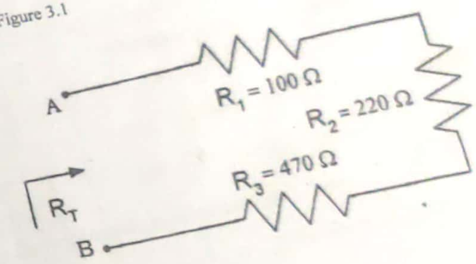


Figure 3.2

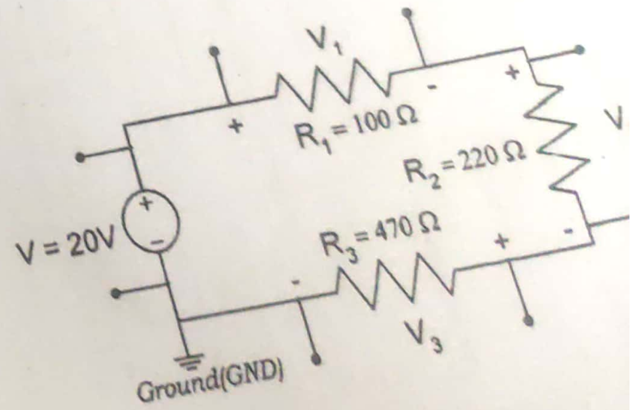


Figure 3.3

$V_{supply} = 05\ V$

$V_{TERM} = \cancel{4.99}\ 5\ V$

DATA SHEET:

Table 3.1

Nominal values of Resistance (Ω)	Measured values of Resistance by Ohmmeter (Ω)	Measured values of Resistance by Tolerance (Ω)	Equivalent Resistance, R_T: Measured R_T by using Ohmmeter (Ω)	Equivalent Resistance, R_T: Calculated $R_T=R_1+R_2+R_3$ (Ω)	Measured voltage across each resistor (V)	Calculated Voltage using VDR (V)
R_1=100	100		780	777	V_1= 0.64	0.64
R_2=220	213				V_2= 1.37	1.36
R_3=470	464				V_3= 2.98	2.97

Calculation:

$V_1 = \frac{100}{780} \times 5\ V = 0.64\ V$; $I_1 = \frac{V_1}{R_1} = \frac{0.64}{100} = 6.4 \times 10^{-3}\ mA$

$V_2 = \frac{213}{780} \times 5\ V = 1.36\ V$; $I_2 = \frac{V_2}{R_2} = \frac{1.37}{213} = 6.43 \times 10^{-3}\ mA$

$V_3 = \frac{464}{780} \times 5\ V = 2.97\ V$; $I_3 = \frac{V_3}{R_3} = \frac{2.98}{464} = 6.42 \times 10^{-3}\ mA$

$\sum V_i = V_{TERM} \approx V_{supply}$

$V_1 + V_2 + V_3 = 4.99 \approx V_{TERM}$ (Measured) $\Rightarrow 0.64 + 1.37 + 2.98 = 4.99 \approx V_{TERM}$

Signature of the Teacher

Discussions:

Q: What can you deduce about the characteristics of a series circuit from observation Table 3.1?

From the observation table we can dedue that,

i) Current flowing through each of the resistance is equal as from observation table we have calculated them approximately equal to 6.4×10^{-3} mA each.

ii) Voltage across each resistor is different. The total voltage measured across the terminal is the same as supply voltage. The total voltage calculated by adding voltages of each of the resistances also provide same value ≈ 5V

Q: From the data found in Table 3.1, mathematically prove that the current in the series network of figure 3.3 is equal for each resistance.

From table 3.1, if we take the values ~~calculated~~ measured and use Ohm's law for each resistance, we get,

$$I_1 = \frac{V_1}{R_1} = \frac{0.64}{100} = 6.4 \times 10^{-3} \text{ mA}$$

$$I_2 = \frac{V_2}{R_2} = \frac{1.37}{213} = 6.43 \times 10^{-3} \text{ mA}$$

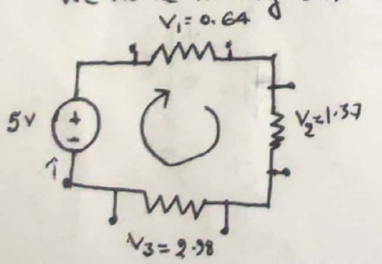
$$I_3 = \frac{V_3}{R_3} = \frac{2.98}{464} = 6.42 \times 10^{-3} \text{ mA}$$

Each of the values give almost identical result which can lead us to conclude $I_1 \approx I_2 \approx I_3$ which means that the current in the series network is equal for each resistance [Proved]

Q: Verify KVL from the data obtained in Table 3.1.

Kirchhoffs Voltage Law (KVL) states that in any closed loop, the total voltage around the loop is equal to the sum of all the voltage drops within the same loop, which is also equal to zero.

We have in Fig 3.3, we use the measured values of voltage, by VDR,



$$V_1 = \frac{100}{780} \approx 0.64 \approx 0.64$$

$$V_2 = \frac{213}{780} \approx 1.36 \approx 1.37$$

$$V_3 = \frac{464}{780} = 2.97 \approx 2.98$$

[Measured Values] almost equal to calculated

By rules of KVL the sum of closed loop (algebraic sum) we get,

$$= -5 + 0.64 + 1.37 + 2.98 = -0.01 \approx 0$$

Thus, the algebraic sum is almost equal to zero, thus KVL is verified from our data.

$V_{supply} = 5$ V

$V_{TERM} = 5$ V

DATA SHEET:

Table 4.1

Nominal values of Resistance (kΩ)	Measured values of Resistance by Ohmmeter (kΩ)	Measured values of Resistance by Tolerance (kΩ)	Equivalent Resistance, R_T		Measured current through each resistor m(A)	Calculated Current using CDR m(A)
			Measured R_T by using Ohmmeter (kΩ)	Calculated $\cancel{1/}R_T = (1/R_1 + 1/R_2 + 1/R_3)^{-1}$ (KΩ)		
R_1=1	0.99		0.59	0.595	I_1= 5	4.67
R_2=2.2	2.14				I_2= 2	2.20
R_3=4.7	4.63				I_3= 1	1.01

$I_T = 8$ mA

Calculation:

$I_1 = I_T \dfrac{1/R_1}{1/R_T} = \cancel{64.64}\ 4.76$ mA ; $V_1 = I_1 R_1 = 4.95\ \Omega$

$I_2 = I_T \dfrac{1/R_2}{1/R_T} = \cancel{29.90}\ 2.20$ mA ; $V_2 = I_2 R_2 = 4.28\ \Omega$

$I_3 = I_T = \dfrac{1/R_3}{1/R_T} = \cancel{13.82}\ 1.01$ mA ; $V_3 = I_3 R_3 = 4.63\ \Omega$

$\sum I_i = I_T$

$\Rightarrow I_1 + I_2 + I_3 = I_T \Rightarrow 4.76 + 2.20 + 1.01 = 7.97$ mA ≈ 8 mA $= I_T$

Discussions:

Q: What can you deduce about the characteristics of a parallel circuit from observation Table 4.1?

From observing Table 4.1 we can deduce that :-

i) Each resistor obtains a different amount of current. Less resistance means more current flowing through each resistor.

ii) Voltage across each resistor is almost same

Q: From the data found in Table 4.1, Calculate I_1, I_2, and I_3 using Ohm's Law.

From the data found in the table we can use the Ohm's law

$$I_1 = \frac{V_1}{R_1} = \frac{4.95}{0.99} = 5mA$$

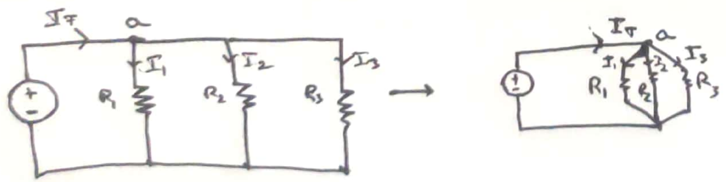
$$I_2 = \frac{V_2}{R_2} = \frac{4.28}{2.14} = 2mA$$

$$I_3 = \frac{V_3}{R_3} = \frac{4.63}{4.63} = 1mA$$

Q: Verify KCL from the data obtained in Table 4.1.

KCL states that, the algebraic sum of all currents entering and exiting a node must equal zero.

What we have made is :



Considering node a, we have to prove,

$I_T - (I_1 + I_2 + I_3) = 0$ for KCL.

$8 - (4.76 + 2.20 + 1.01) = 0.03 \approx 0$

Thus, Kirchhoff's Current law can be proven from the data.