ACTIVITY-1

Aim

To determine the purity of liquid in terms of refractive index using travelling microscope.

Apparatus Required

Travelling microscope, Reading lens, 50 ml beaker, water, saw dust, etc.

Formula

Refractive Index of liquid $\mu = \frac{(C-A)}{(C-B)}$ {no unit}

where,

A = Reading of microscope when ink dot is focused directly

B = Reading of microscope when ink dot is focused through water

C = Reading of microscope when saw dust is focused.

S.No	A			B			C			(C−A)	(C−B)	μ
	MSR	VSC	TR	MSR	VSC	TR	MSR	VSC	TR			
	cm	div	cm	cm	div	cm	cm	div	cm			
1.	6.4	10	6.41	7.5	5	7.505	10.1	13	10.113	3.703	2.608	1.419
2.	6.4	10	6.41	7.6	46	7.646	10.7	9	10.709	4.299	3.063	1.403
3.	6.4	10	6.41	7.7	1	7.701	11.3	18	11.318	4.908	3.617	1.356

Total μ = 1.392

TR = MSR + (VSC × LC)

Least Count = 0.001 cm

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Calculations -

$$\mu = \frac{(C-A)}{(C-B)} \quad \{\text{no unit}\}$$

$$= \frac{10.113 - 6.41}{10.113 - 7.505} = \frac{3.703}{2.608} =$$

$$\mu = 1.419$$

Result -

The purity of the given liquid evaluated in terms of Refractive Index is determined to be

$\mu = 1.392$

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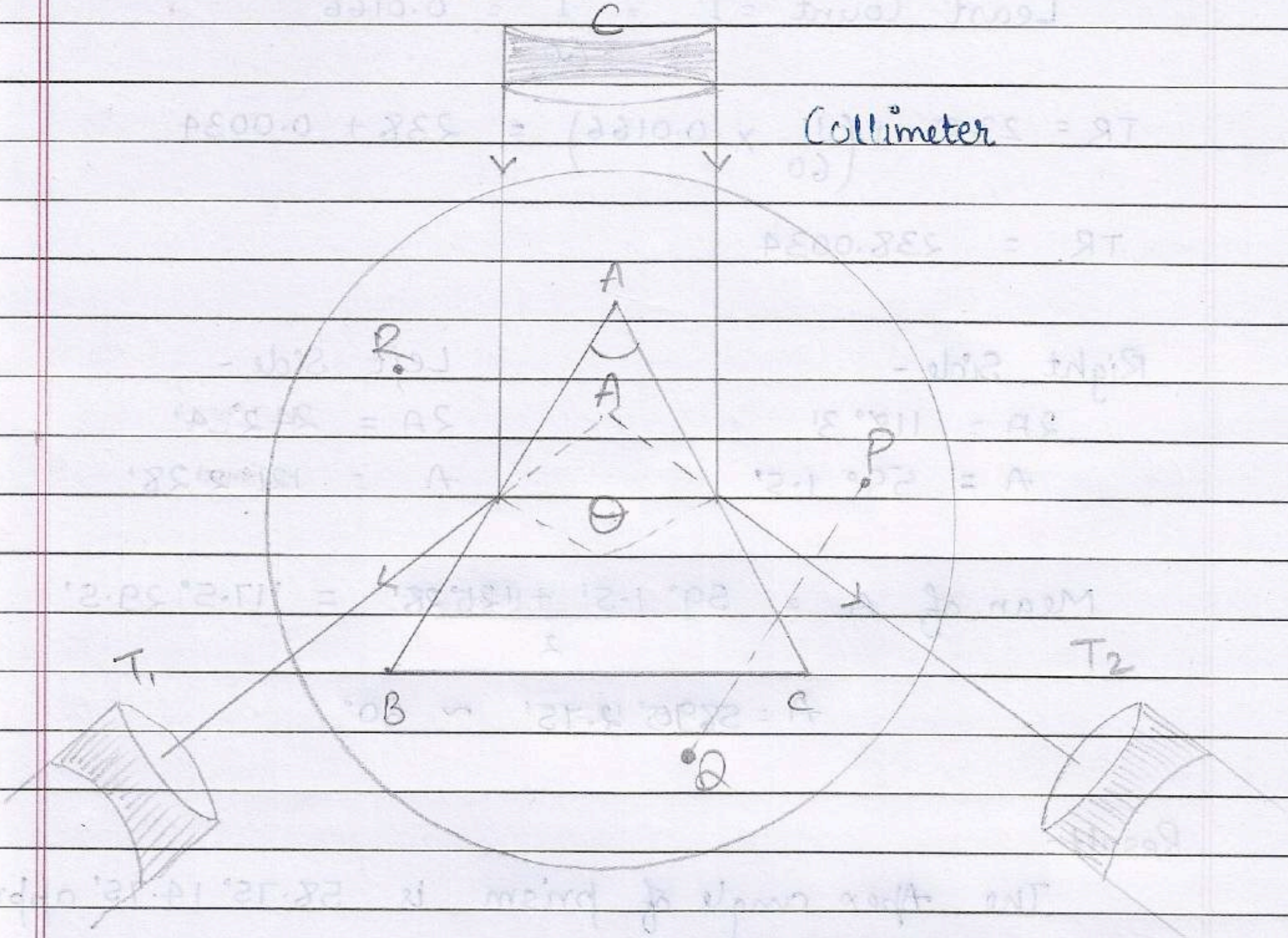
ACTIVITY - 2

Aim: To determine the angle / apex angle of prism.

Apparatus:

- Spectrometer
- Spirit Level
- Magnifying Glass
- Glass Prism
- Mercury vapour Lamp.



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Observation Table:

Reading of Reflected Ray	RIGHT VERNIER			LEFT VERNIER		
	MSR	VSC	TR	MSR	VSC	TR
Face-I	238°	11'	238° 11'	58°	10'	418° 10'
Face-II	120°	8'	120° 8'	300°	14'	300° 14'
Face differ. (I&II)			118° 3'			117° 56'

Calculations:

Least Count $= 1' = \frac{1}{60°} = 0.0166°$

$TR = 238° + \left(\frac{11}{60} \times 0.0166\right) = 238 + 0.0034$

$TR = 238.0034$

Right Side -

$2A = 118° 3'$

$A = 59° 1.5'$

Left Side -

$2A = 117° 56'$

$A = 58.5° 28'$

Mean of $A = \frac{59° 1.5' + 58.5° 28'}{2} = 117.5° 29.5'$

$A = 58.75° 14.75' \sim 60°$

Result-

The Apex angle of prism is 58.75° 14.75' approx 60° (equilateral prism).

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ACTIVITY-3

Aim:-

Given the angle of the prism, To determine the angle of minimum deviation of the prism & hence calculate its Refractive Index.

Apparatus:-

Spectrometer, Given Prism, Mercury Vapour lamp

Formula Used:-

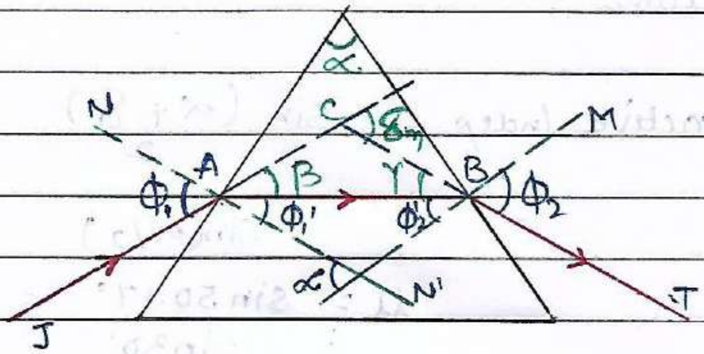
Refractive Index (μ) of the prism is given by-

$$\mu = \frac{\sin\left(\frac{\alpha + \delta}{2}\right)}{\sin\left(\frac{\alpha}{2}\right)}$$

where,

α is angle of Prism

δ is angle of Minimum Deviation.



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Observation Table :

		VERNIER - 1			VERNIER - 2		
		MSR	VSC	TR	MSR	VSC	TR
Reading of Refractive Index Image (i)	G	140°	4	140°4'	319°	17	319°17
	V	139°	10	139°10'	319°	5	319°5'
	Y	140°	14	140°14'	320°	10	320°10
	R	141°	20	141°20'	320°	20	320°20
Reading of Direct Ray (ii)		180°	0'	180°	0°	0'	360°
Difference b/w (ii) & (i) D	G	39°	56	39°56'	40°	43	40°43'
	V	40°	50	40°50'	40°	55	40°55'
	Y	39°	46	39°46'	39°	50	39°50'
	R	38°	40	38°40'	39°	40	39°40'
Mean Value of D			G	-	40.33°		
			V	-	40.88°		
			Y	-	39.80°		
			R	-	39.17°		

Calculation :-

for G -

$$\text{Refractive Index} = \frac{\sin\left(\frac{\alpha+\delta}{2}\right)}{\sin(\alpha/2)} = \frac{\sin\left(\frac{60+40.33^\circ}{2}\right)}{\sin 30^\circ}$$

$$\mu = \frac{\sin 50.17^\circ}{\sin 30^\circ} = \frac{0.77}{0.5}$$

$$\boxed{\mu = 1.54}$$

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For V:-

Refractive Index (μ) = $\frac{\sin\left(\frac{60+40.88}{2}\right)}{\sin(30)}$ = $\frac{\sin(50.44)}{\sin 30^\circ}$

= $\frac{0.77}{0.5}$ $\boxed{\mu = 1.54}$

For Y:-

Refractive Index (μ) = $\frac{\sin(60+39.8^\circ)/2}{\sin 30^\circ}$ = $\frac{\sin(49.9^\circ)}{\sin 30^\circ}$

= $\frac{0.77}{0.5}$ ⇒ $\boxed{\mu = 1.54}$

For R:-

Refractive Index (μ) = $\frac{\sin(60+39.17)/2}{\sin 30^\circ}$ = $\frac{\sin(49.59)}{\sin 30^\circ}$

= $\frac{0.76}{0.5}$ ⇒ $\boxed{\mu = 1.52}$

Result:-

The refractive Index (μ) of the given prism is calculated as 1.535

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Activity - 4

Aim -

To determine the number of lines in a given grating using a laser source of light.

Apparatus -

He-Ne laser or semiconduncting laser, grating, scale grating stand.

formula -

$$N = \frac{\sin(\theta)}{n\lambda} \text{ lines per meter}$$

Where,

λ = Wavelength of the laser light used in the exp. (nm).

θ = Angle of diffraction (degree).

n = Order of diffraction

N = The density of lines in the grating = 7667.139 lines/inch

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Tabulation -

Diffraction Order (n)	D	2L	L	tanθ (L/D)	θ $tan^{-1}(L/D)$	sinθ	Mean sinθ	N (lines/inch)
	10	4.1	2.05	0.205	0.202	0.201		
	12	4.9	2.45	0.204	0.201	0.2		
1	14	5.8	2.9	0.207	0.204	0.203	0.202	7781.632
	16	6.7	3.35	0.209	0.206	0.205		
	18	7.4	3.7	0.206	0.203	0.202		
	10	8.6	4.3	0.43	0.406	0.395		
	12	10.3	5.15	0.429	0.405	0.394		
2	14	12.2	6.1	0.436	0.411	0.4	0.4	7708.51
	16	14.3	7.15	0.447	0.42	0.408		
	18	16	8	0.444	0.418	0.406		
	10	14.9	7.45	0.745	0.64	0.597		
	12	18.3	9.15	0.763	0.652	0.607		
3	14	20.2	10.1	0.721	0.625	0.585	0.597	7658.48
	16	24	12	0.75	0.644	0.6		
	18	26.7	13.35	0.742	0.638	0.596		
	10	26.2	13.1	1.31	0.919	0.795		
	12	29.3	14.65	1.221	0.885	0.774		
4	14	34.6	17.3	1.236	0.891	0.778	0.781	7519.935
	16	40	20	1.25	0.896	0.781		
	18	44.8	22.4	1.244	0.894	0.78		
							Mean	7667.139

Observation-

for n=1:-

$$\text{Mean } \sin\theta = (0.201 + 0.2 + 0.203 + 0.205 + 0.202)/5$$
$$= 1.011/5$$
$$= 0.202$$

$$N = (\sin\theta)/(n \times \lambda)$$

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$$N = \frac{0.202}{1 \times 660 \times 10^{-9} \times 39.3701}$$

$$= \frac{0.202 \times 10^{8}}{66 \times 39.3701}$$

$$= \frac{0.202}{2.598 \times 10^{-5}}$$

$N = 7781.632$ lines/inches

Form-2 -

Mean $\sin\theta = 0.4$

$$N = (\sin\theta)/(n \times \lambda)$$

$$= \frac{0.4}{2 \times 2.598 \times 10^{-5}}$$

$$= \frac{0.2}{2.598 \times 10^{-5}}$$

$N = 7708.51$ lines/inches

Mean of $N = (7781.632 + 7708.51 + 7658.48 + 7519.935)/4$

$N = 7667.139$ lines/inches

Result -

The density of the lines in the giving grating was determined by to be $N = 7667.139$ lines/inches

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Activity -5

Aim-

Determination of the track width (periodicity) in a given CD by a Laser diffraction method and then determine the amount of data storage in a given CD.

Apparatus Required-

Laser Source, Written CD-R, Planner Screen & Scale.

formula Used-

$n\lambda = d\sin\theta$ (For reflected Diffraction Pattern)

where,

λ is wavelength of laser

θ is angle of diffraction

n is the orders of differaction

d is the track width (to be determined)

Track width can be determined by using the following equation

$d = \lambda n / \sin\theta$ µm

Observation Table:-

n	D	2L	L	$\tan\theta = L/D$	$\theta = \tan^{-1}(L/D)$	$\sin\theta$	mean $\sin\theta$	Track Width (µm)
	5	6	3	0.6	30.964	0.514		
1	6	7	3.5	0.583	30.256	0.504	0.501	1.317
	7	8	4	0.571	29.745	0.496		
	8	9	4.5	0.563	29.358	0.49		
	5	16	8	1.6	57.995	0.848		
2	6	18	9	1.5	56.31	0.832	0.832	1.585
	7	20	10	1.429	55.008	0.819		
	8	24	12	1.5	56.31	0.832		
							Mean	1.451

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Calculations-

$d = n\lambda / \sin\theta$

$\lambda = 660 nm = 660 \times 10^{-3}$ µm

$n = 2, \quad D = 5$

$2L = 16 \Rightarrow L = 8$

$\tan\theta = L/D = 8/5 = 1.6$

$\theta = \tan^{-1}(L/D) = 57.995°$

$\sin\theta = \sin(57.995°)$

$\sin\theta = 0.848$

Mean of $\sin\theta = (0.848 + 0.832 + 0.819 + 0.832)/4$

$= 0.832$

$d = \frac{(2 \times 660 \times 10^{-3})}{0.832} = \frac{1320}{832}$

$d = 1.585$ µm

Mean of $d = (1.317 + 1.585)/2$

$d = 1.451$ µm

Result -

The track width of the CD is 'd' = 1.451 µm

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Activity-6

Aim-

To determine the Numerical Aperture (NA) & acceptance Ue. (a) of the given two different (1m & 1/2m cables) optical fibres to find their suitability in telecommunication applications. Observing the optical power losses, when light are passing through two different (1m & 1/2m cables) optical fibres during, (a) when they are not coupled each other & (b) when they are coupled each other through an in-line adaptor.

Apparatus Required-

Fiber optic LED light source, fiber optic power meter, fibre optic (FO) cable 1m, FO cable 1/2m. In-line adaptor (to connect 2 cables), NA-Jig (L-Shape with scale on one side and connector on other side).

Formula-

$$NA = \sin\theta_a = \frac{W}{\sqrt{(4L^2+W^2)}} \quad \text{(No unit)}$$

where,

W = Diameter of spot (m)

L = Distance b/w the fiber end and screen (m)

a = Acceptance Angle (deg)

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For FO with length 1/2 m

Powerloss = -37.4 dB

Serial No.	L (mm)	W (mm)	NA No unit	θ_a deg
1)	4	10	0.781	51.35
2)	8	15	0.684	43.15
3)	14	20	0.581	35.52
4)	20	25	0.53	32
		Mean	0.644	40.505

For FO with length 1m

Powerloss = -49.9 dB

Serial No.	L (mm)	W (mm)	NA No unit	θ_a deg
1)	5	10	0.707	44.99
2)	8	15	0.684	43.15
3)	12	20	0.64	39.79
4)	15	25	0.64	39.79
		Mean	0.669	41.94

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Calculations-

For optical fibre cable of 1/2 m

1st reading

$L = 4mm \qquad W = 10mm$

$$N = \sin\theta_a = \frac{W}{\sqrt{4L^2+W^2}}$$

$$= \frac{10mm}{\sqrt{4(4mm)^2+(10mm)^2}}$$

$$= \frac{10\,\cancel{mm}}{\sqrt{4\times16+100}\,\cancel{mm}}$$

$$= \frac{10}{\sqrt{164}}$$

$$= \frac{10}{12.80}$$

$$= 0.78$$

$$\theta_a = \sin^{-1}(0.78)$$

$$= 51.3^\circ$$

Similarly,

For $L = 8mm \qquad W = 15mm$

$NA = 0.68 \quad , \quad \theta_a = 43.15^\circ$

So

For 1/2 m cable -

mean of NA = 0.644

mean of θ_a = 40.505 deg.

For 1m cable -

mean of NA = 0.664

mean of θ_a = 41.940 deg.

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Result-

① The numerical aperture of the given optical fibre ($1/2$ m) = 0.644

② The acceptance angle for the given optical fibre ($1/2$ m) = $40.50°$

③ The Numerical aperture of the given optical fibre (1 m) = 0.669

④ The acceptance angle of the given optical fibre (1m) = $41.94°$

⑤ The optical power loss, when the light passing through optical fibre cable ($1/2$ m) = -37.4 dB

⑥ The optical power loss when the light passing through optical fibre cable (1 m) = -49.9 dB

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ACTIVITY - 7

Aim:

To find a particle size from laser diffraction pattern.

Table:

Sl. No.	Order of Diffraction	d (cm)	Diameter of dark ring (cm)	Radius of dark ring (cm)	Size of particle D
1	1	10	2	1	8.052
	2		4	2	7.359
2	1	12	2.5	1.25	7.730
	2		4.5	2.25	7.850
3	1	16	2.8	1.4	9.202
	2		5.8	2.9	8.120
				Mean =	8.052

where $\lambda = 660$ nm

Calculations:

for order of diffraction 1-

$\lambda = 660 \times 10^{-9}$

$$D = \frac{(1.22 \times 660 \times 10^{-9} \times 10)}{1}$$

$$\boxed{D = 8.052\ \mu m}$$

For order of diffraction 2.

$$D = \frac{2.23 \times 660 \times 10^{-9} \times 10}{2}$$

$$\boxed{D = 7.359\ \mu m}$$

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Result:-

For diffraction order 1-

$$D = \frac{1.22 \times 660 \times 10^{-9} \times 12}{1.25}$$

$D = 7.730\ \mu m$

For diffraction order 2-

$$D = \frac{2.23 \times 660 \times 10^{-9} \times 12}{2.25}$$

$D = 7.850\ \mu m$

Mean of $D = (8.052 + 7.359 + 7.730 + 7.850 + 9.202 + 8.120) / 6$

$= (48.313) / 6$

$\boxed{D = 8.052\ \mu m}$

Result:-

The size of particle is 8.052 micrometer.

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Activity - 8

Aim -

To determine the value of Planck's universal constant using LED's.

Apparatus -

LED'S, digital voltmeter, micro-ammeter & ten turn linear potentiometer.

Principle -

LED is a p-n junction and it work on the principle of electro-loninsence; a phenomenon in which material emit light in response to the pasage of electric current.

For the conservation of energy:

$$E = eV_0 = h\nu = \frac{hc}{\lambda}$$

$$\left[h = \frac{eV_0\lambda}{c} \right]$$

where, e = charge of e-

λ = wavelength of photon emit fr LED

c = speed of light

V_0 = Barier Potential

h = Planck's constant

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TABULATION-

Blue		Green		Yellow		Red	
V	I	V	I	V	I	V	I
0.1	0	0.1	0	0.6	0	0.1	0
0.2	0	0.2	0	0.2	0	0.2	0
0.4	0	0.4	0	0.3	0	0.3	0
0.6	0	0.6	0	0.4	0	0.4	0
0.8	0	0.8	0	0.6	0	0.6	0
1	0	1	0	0.7	0	0.7	0
1.3	0	1.3	0	0.8	0	0.8	0
1.6	0	1.6	0	0.9	0	0.9	0
1.9	0	1.9	0	1	0	1	0
2	0	2	0	1.44	1	1.35	1
2.31	1	2.08	1	1.47	2	1.37	2
2.32	2	2.1	2	1.49	3	1.39	3
2.34	3	2.13	3	1.51	4	1.4	4
2.35	4	2.14	4	1.52	6	1.41	5
2.37	5	2.16	6	1.53	7	1.42	6
2.38	6	2.18	7	1.54	8	1.43	8
2.39	8	2.19	8	1.55	10	1.44	10
2.4	10	2.2	9	1.56	14	1.45	13
2.41	13	2.22	11	1.57	17	1.46	16
2.42	16	2.23	13	1.58	20	1.47	20
2.43	21	2.24	15	1.59	27	1.48	25
2.44	26	2.25	16	1.6	30	1.49	32
2.45	33	2.26	19	1.61	31	1.5	40
2.46	41	2.27	21	1.62	43	1.51	49
2.47	48	2.28	23	1.63	51	1.52	65
2.48	59	2.29	26	1.64	68	1.53	78
2.49	75	2.3	29	1.65	83	1.54	97
2.5	88	2.31	32	1.66	97	1.55	119

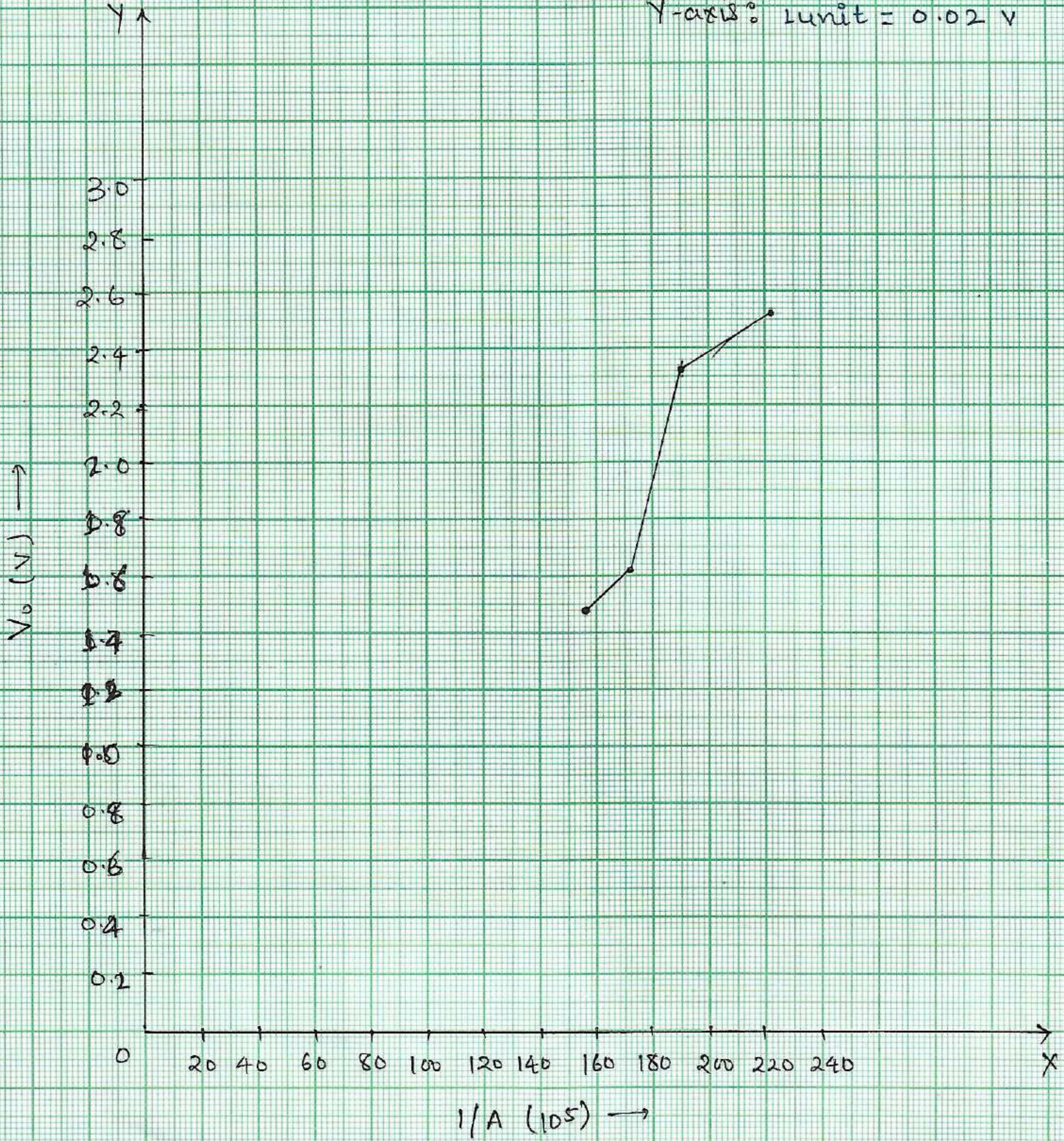
V	I	V	I	V	I	V	I
2.51	125	2.32	36	1.67	142	1.56	154
2.52	149	2.33	41	1.68	169	1.57	175
2.53	169	2.34	44	1.69	220	1.58	222
2.54	208	2.35	50	1.7	241	1.59	304
2.55	222	2.36	54	1.71	324	1.6	335
2.56	244	2.37	60				
		2.38	68				
		2.39	78				
		2.4	90				
		2.41	102				
		2.42	111				
		2.43	114				
		2.44	127				
		2.45	141				
		2.46	156				
		2.47	169				
		2.48	185				
		2.49	208				
		2.5	235				

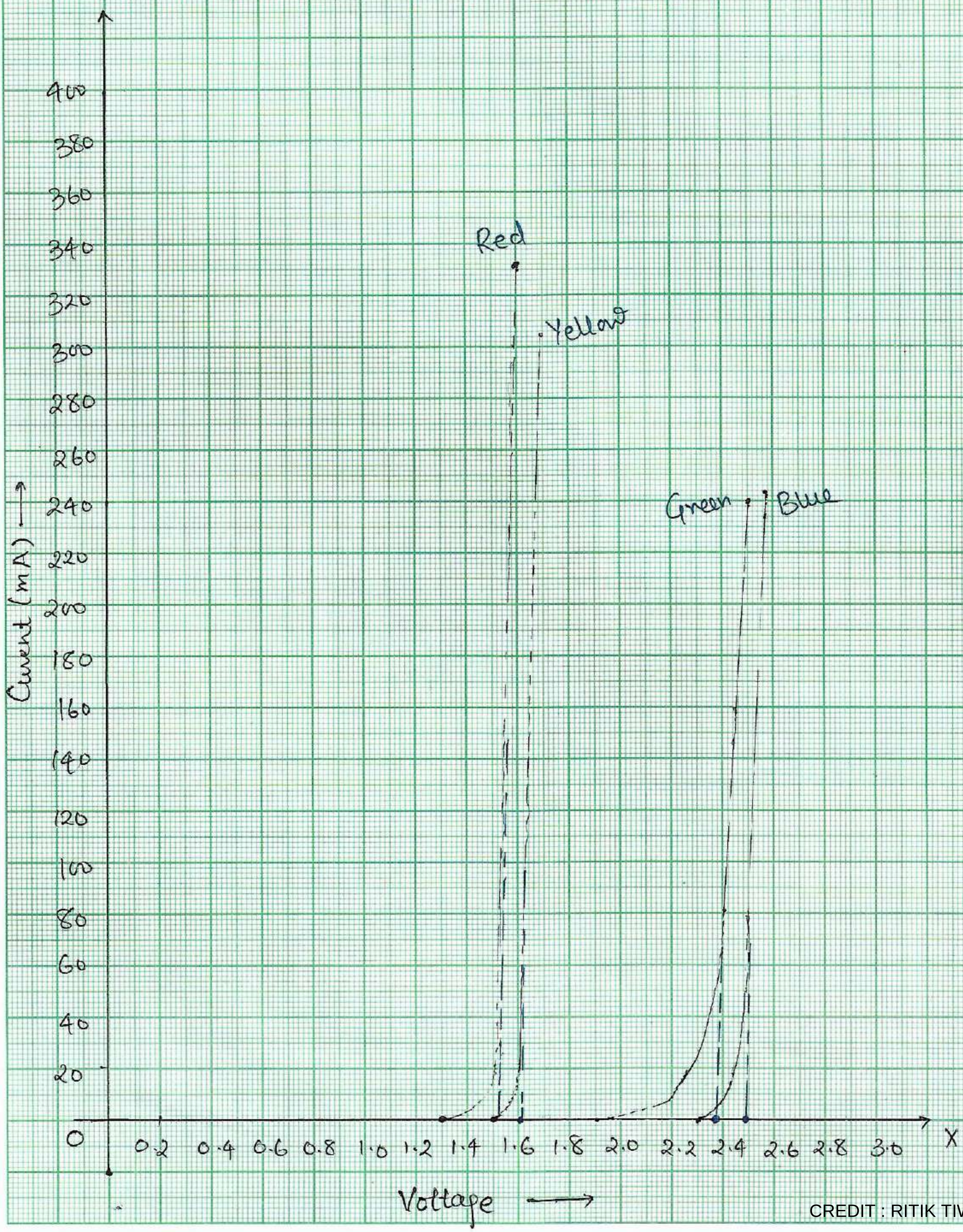
LED Color	Wavelength	$1/\lambda$	Barrier Potential
Blue	450×10^{-9}	0.00222×10^{9}	2.44
Green	520×10^{-9}	0.00192×10^{9}	2.30
Yellow	580×10^{-9}	0.00172×10^{9}	1.60
Red	630×10^{-9}	0.00159×10^{9}	1.48

Scale

X-axis: 1 unit = 2 X 105 m-1

Y-axis: 1 unit = 0.02 V





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Calculation:

$N = 4$

$\Sigma x_i = 0.00745 \times 10^9$, $\Sigma x_i^2 = 14101.3 \times 10^9$

$\Sigma y_i = 7.82$, $\Sigma x_i y_i = 0.01499 \times 10^9$

$$\text{Slope} = \frac{N \Sigma x_i y_i - \Sigma x_i \Sigma y_i}{N \Sigma x_i^2 - (\Sigma x_i)^2}$$

$$= \frac{(4 \times 0.01499 - 0.058259) \times \cancel{10^9}}{(56405.2 - 55502.5) \times \cancel{10^9}}$$

$$= 1.217 \times 10^{-6}$$

$$h = \frac{\text{Slope} \times e}{c} = \frac{1.217 \times 10^{-6} \times 1.6 \times 10^{-19}}{3 \times 108}$$

$$= 6.49 \times 10^{-34}$$

- Slope of $1/\lambda - V_0$ curve $(hc/e) \Rightarrow S = 1.21725 \times 10^{-6}$
- Coefficient $(C/e) \Rightarrow C = 1.875 \times 10^{27}$
- Planck's constant $(S/c) \Rightarrow h = 6.492 \times 10^{-34}$

Result -

The value of Planck's constant is 6.492×10^{-34} Js