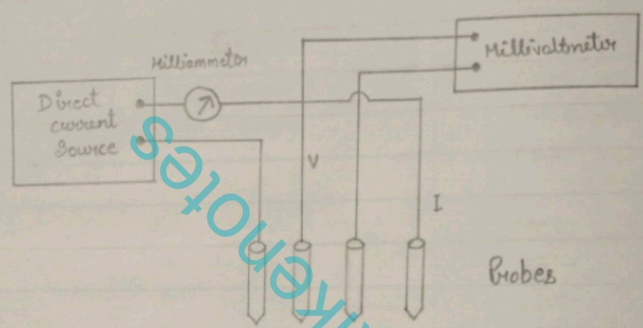


Circuit used for Resistivity measurements

Date

Expt. No. 1 Page No. 1

Object – Study of temperature dependence of resistance of a semiconductor using four probe method.

Apparatus – Probes arrangement, sample, oven, thermometer four probe setup, constant current generation.

Theory and formula –

four sharp probes are placed on a flat surface of the material to be measured current is passed through the two outer electrodes and the floating potential is measured across the inner pair.

four probes are spaced S_1, S_2 and S_3 apart current I is passed through the outer probes 1 and 4 and the floating potential v is measured across the inner pair of probes. (2 and 3).

When the points spacing equal

$$S_1 = S_2 = S_3 = S_4$$

We get resistivity (ρ_0)

$$\rho_0 = \frac{V}{I} \times 2\pi S$$

Here, v = floating potential difference between inner probe in V

I = Current through the outer pair of probes in the width of slice is ω

S = Spacing between the probes in meters

Resistivity –

$$\rho = \frac{\rho_0}{G_7(\omega/S)}$$

X2πS

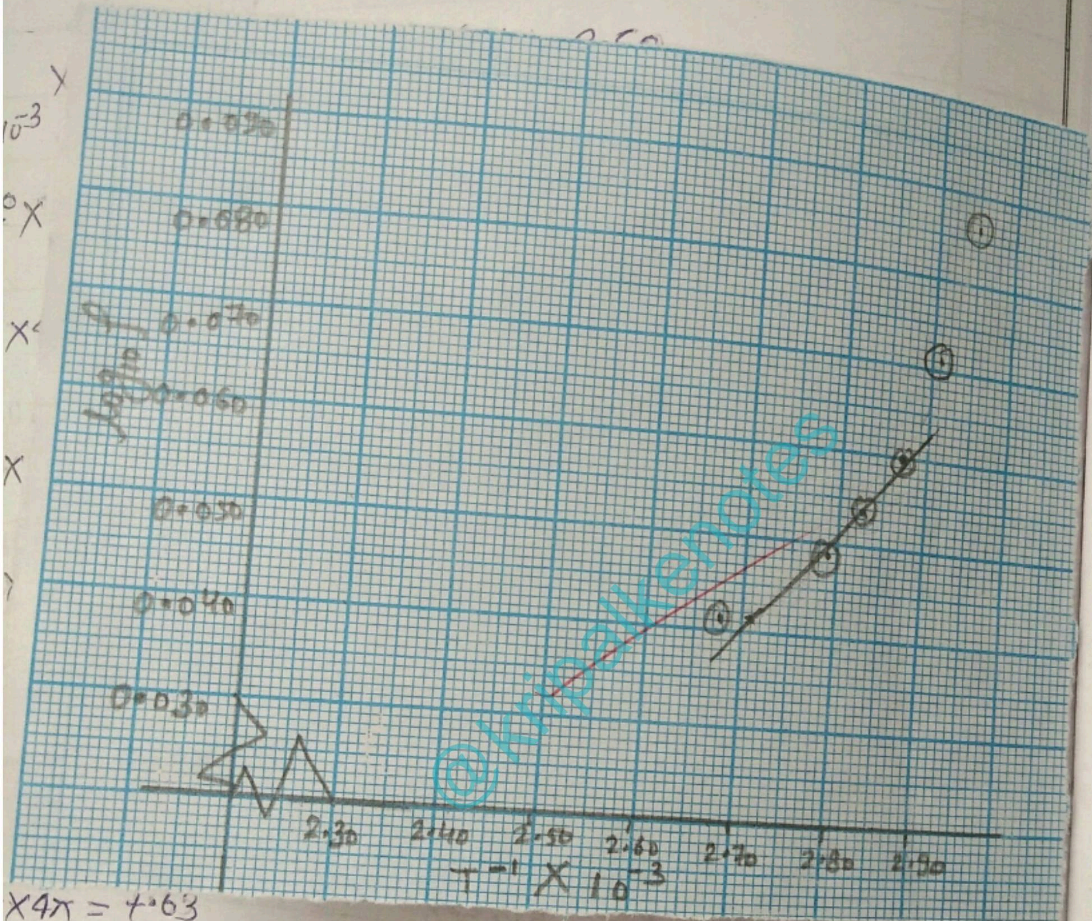
X

10^{-3}

X

X

X



$\times 4\pi = 7.63$

$= \left[W/S = \frac{0.5}{2} = 0.25 \right]$

$G_7(W/S) = 6.93$

.22

.18

$S_7 = \frac{7.68}{6.93} = 1.10$

.15

Expt.

S.No.
1.
2.
3.
4.
5.
6.
7.
8.

1.

2.

Calculation —

$\rho_0 = \frac{V}{I} \times 2\pi S$

$\rho_0 = \frac{1.76}{2.6 \times 10^{-3}} \times 2\pi \times 2 \times 10^{-3} = \frac{1.76}{2.6} \times 4\pi = 8.50$

$\rho_0 = \frac{1.70}{2.6} \times 4\pi = 8.21$

$\rho_0 = \frac{1.66}{2.6} \times 4\pi = 8.01$

$\rho_0 = \frac{1.63}{2.6} \times 4\pi = 7.87$

$\rho_0 = \frac{1.61}{2.6} \times 4\pi = 7.77$

$\rho_0 = \frac{1.60}{2.6} \times 4\pi = 7.72$

$\rho_0 = \frac{1.59}{2.6} \times 4\pi = 7.68$

$\rho_0 = \frac{1.58}{2.6} \times 4\pi = 7.63$

$\rho = \frac{\rho_0}{G_7(w/s)} =$ $\left[w/s = \frac{0.5}{2} = 0.25 \right]$

$G_7(w/s) = 6.93$

$\rho_1 = \frac{8.50}{6.93} = 1.22$

$\rho_2 = \frac{8.21}{6.93} = 1.18$

$\rho_3 = \frac{8.01}{6.93} = 1.15$

$\rho_4 = \frac{7.87}{6.93} = 1.13$

$\rho_5 = \frac{7.77}{6.93} = 1.12$

$\rho_6 = \frac{7.72}{6.93} = 1.11$

$\rho_7 = \frac{7.68}{6.93} = 1.10$

$\rho_8 = \frac{7.63}{6.93} = 1.10$

Date ________

Expt. No. ________ Page No. 2

Observation –

Distance between probes $S = 2mm = 2 \times 10^{-3} m$.

Thickness of the crystal $w = 0.5mm = 5 \times 10^{-4} m$.

Observation table –

S.No.	Temperature(°c)	Volts(V)	Temp.(K)	ρ (Ω/cm)	$T^{-1} \times 10^{-3}$	$\log_{10} \rho$
1.	65	1.762	338	1.22	2.95	0.086
2.	70	1.704	343	1.18	2.91	0.071
3.	75	1.664	348	1.15	2.87	0.060
4.	80	1.638	353	1.13	2.83	0.053
5.	85	1.616	358	1.12	2.79	0.049
6.	90	1.601	363	1.11	2.75	0.045
7.	95	1.596	368	1.10	2.71	0.041
8.	100	1.584	373	1.10	2.68	0.041

Result –

We obtain the graph for this.

Precaution –

1. Wires should be tightly connected
2. Current should be constant.
3. Carefully notedown thermometer reading.

Nishikhat
31-05-21

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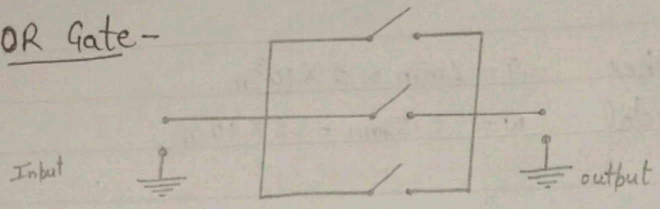
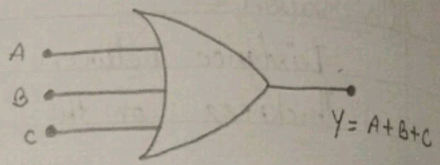
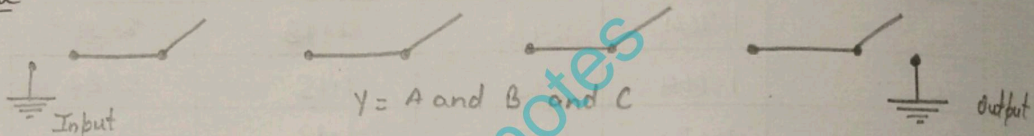
OR Gate -



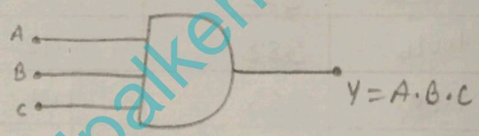
Y = A or B or C



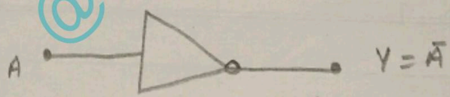
AND Gate -



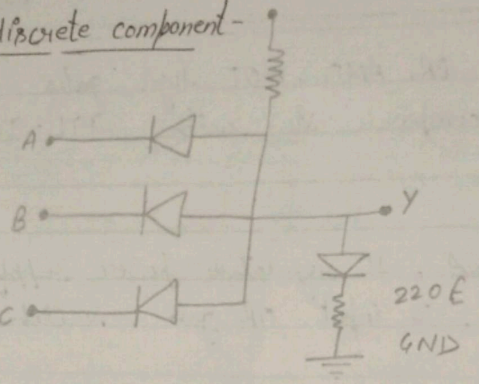
Y = A and B and C



NOT Gate -

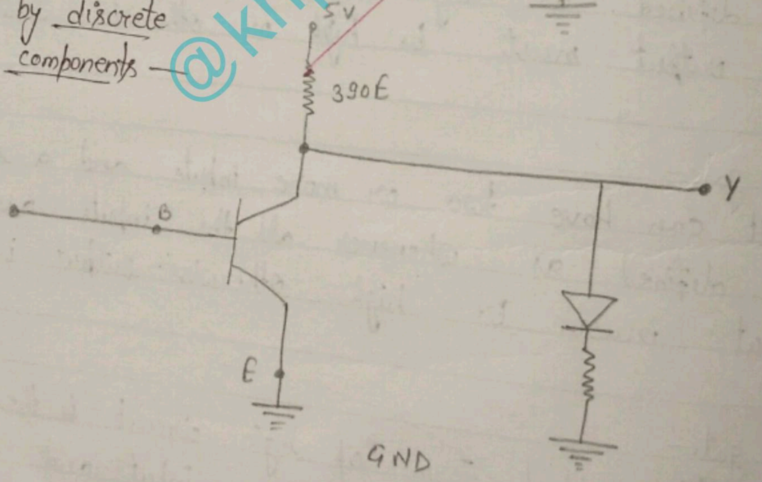


AND-Gate discrete component -



NOT-Gate by TTL (ICs) —

NOT-Gate by discrete components —



Expt. No. 2

Object - To study OR, AND, NOT logic gates using discrete compound and compare it with TTL - ICs.

Apparatus -
5V at 100mA, DC regulated power supply, NOT gate, 3 input AND gate, 3 input OR gate, switch, LED patch corale.

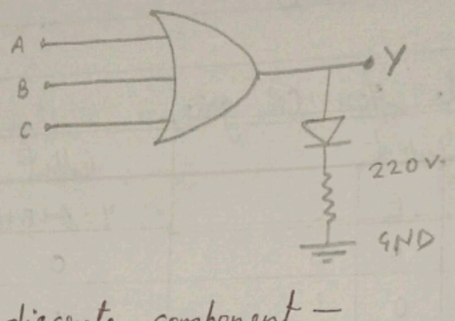
Theory -
All digital equipments, simple or complex is constituted from just a few basic circuits called logic elements.

OR gate -
It can have two or more inputs and a single output. It is defined as any one or all the inputs are high then output must be high or otherwise low.

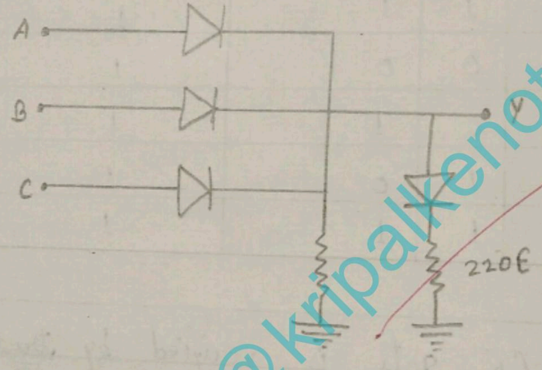
AND gate -
It can have two or more inputs and a single output. It is defined as whenever all the inputs are high, then output must be high otherwise output is low.

NOT gate -
The simplest form of logic circuit is the inverter or NOT gate. It can have one input and one output terminal.

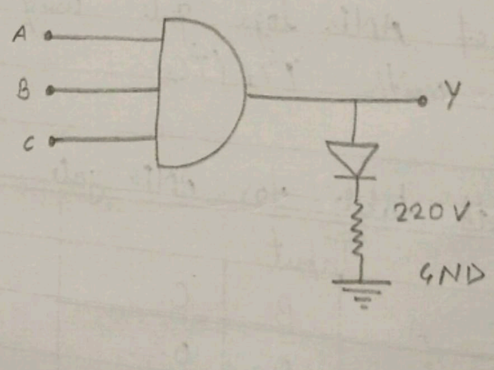
OR gate by TTL (ICs) —



OR-gate by discrete component —



AND gate by TTL (ICs) —



Date

Expt. No.

Object-1. Study of OR logic gate using discrete components and comparison with TTL (ICs)

Observation - Truth table for OR gate

S.No.	Input			Output
	A	B	C	Y = A+B+C
1	0	0	0	0
2.	0	0	1	1
3.	0	1	0	1
4.	0	1	1	1
5.	1	0	0	1
6.	1	0	1	1
7.	1	1	0	1
8.	1	1	1	1

Result - Hence the OR gate is verified by truth table.

Object-2. Study of AND logic gate using discrete components in comparison with TTL (ICs)

Observation - Truth table for AND gate

S.No.	Input			Output
	A	B	C	Y = A·B·C
1.	0	0	0	0
2.	0	0	1	0
3.	0	1	0	0
4.	0	1	1	0
5.	1	0	0	0

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6.	1	0	1	0
7.	1	1	0	0
8.	1	1	1	1

Result- The AND logic gate is verified by truth table

Object 3. Study of NOT logic gate using discrete components in comparison with TTL (ICs)

Observation- Truth table for NOT gate

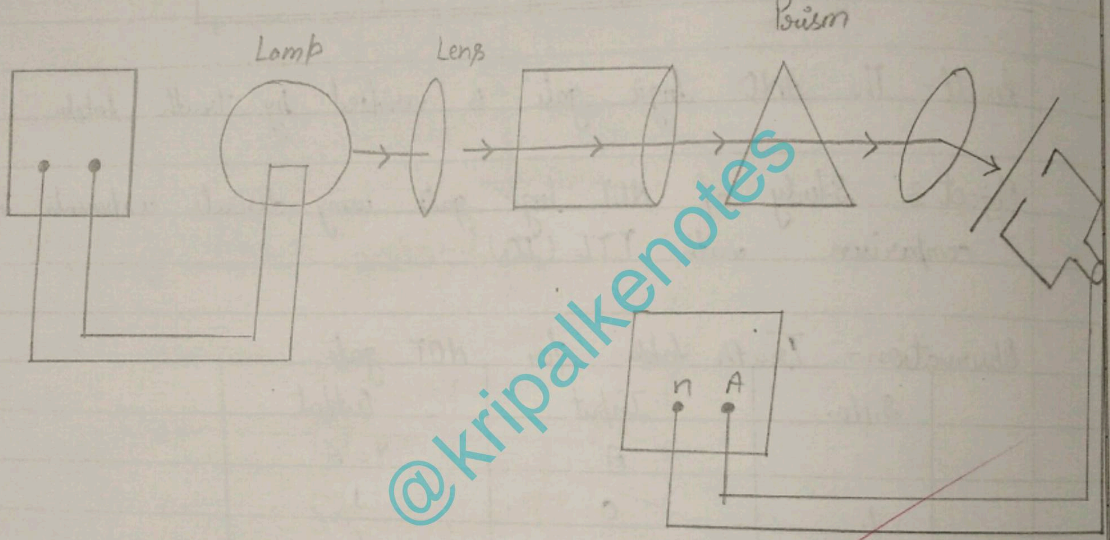
S.No.	Input A	Output $Y = \bar{A}$
1.	0	1
2.	1	0

Result - The NOT logic gate is verified by truth table.

Precautions-

1. Connect the wires properly.
2. Power supply should not exceed 5V.

31-03-21


Lamp
Lens
Prism
n
A

Date

Expt. No. 3 Page No. 6

Object – Determination of planks constant by spectrometer and photovoltaic cell.

Apparatus – Spectrometer, digital manometer, prism, power supply photovoltaic cell and double convex lens.

Theory and formula –

The planck's radiation formula –

$$E_\lambda d\lambda = \frac{C_1 \lambda^{-5} d\lambda}{(e^{C_2/\lambda T} - 1)}$$

where, $C_1 = 8\pi hc$

$C_2 = \frac{hc}{k}$

$$E_\lambda d\lambda = \frac{C_1}{\lambda^5} \frac{1}{(e^{C_2/\lambda T} - 1)} d\lambda$$

If we substitute the values of h, c and k than the exponent become very large.

$$E_\lambda d\lambda = \frac{C_1}{\lambda^5} e^{-C_2/\lambda T} d\lambda$$

$$= \frac{C_1}{\lambda^5} e^{-C_2/\lambda T} d\lambda$$

Put $A = \frac{C_1}{\lambda^5}$ and $B = \frac{C_2}{\lambda}$

Then, $E_\lambda d\lambda = A \cdot e^{-B/T} d\lambda$

Here, $\log_{10} A - \frac{B}{2.303} \times \frac{1}{T} = \log_{10} m + \log_{10} \theta$

Wonder

Teacher's Signature :

where,

$$\log_{10} E_\lambda d\lambda = \log_{10} m\theta = \log_{10} m + \log_{10}\theta$$

$$\log_{10}\theta = \log_{10} A - \frac{B}{2.303T} - \log_{10} m$$

$$\log_{10}\theta = \log_{10}\frac{A}{m} - \frac{B}{2.303T}$$

$$\log_{10}\theta = \log_{10} D - \frac{B}{2.303T} \qquad \left\{\because D = \frac{A}{m}\right\}$$

Comparing this with

$$y = c - mx$$

$$m = \frac{B}{2.303} = \frac{hc}{k\lambda(2.303)}$$

$$\boxed{h = \frac{m k\lambda(2.303)}{c}}$$

Temperature T can be obtained by languisi formula

$$\frac{R_T}{R_0} = \left(\frac{T}{T_0}\right)^{1.2}$$

where

R_T = Resistance of bulb filament at temp. T.

R_0 = Resistance of bulb filament at temp. 0°C (T_0)

At room temperature

$$\frac{R_R}{R_0} = \left(\frac{T_R}{T_0}\right)^{1.2}$$

R_R = resistance of bulb filament at room temp.

At dropper point (T_D)

$$\frac{R_D}{R_0} = \left(\frac{T_D}{T_0}\right)^{1.2}$$

Calculation -

Planck's constant

$$h = \frac{mk\lambda \times (2.303)}{c}$$

$$m = \Delta \log_{10} \theta / \Delta(1/T)$$

$$m = \frac{0.64 - 0.53}{(0.0018 - 0.0014) \times 10^{-4}} = \frac{0.11}{0.0004}$$

$$m = 275$$

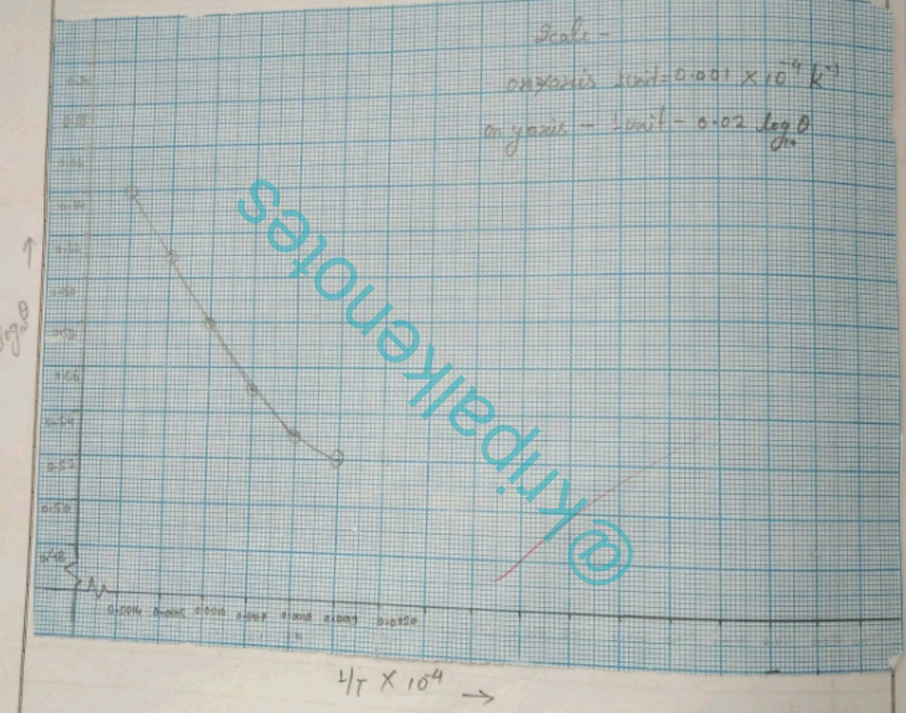
Now,

$$h = \frac{275 \times 1.38 \times 10^{-23} \times 5.8823 \times 10^{-10} \times 2.303}{3 \times 10^{8}}$$

$$h = \frac{5089.23 \times 10^{-33}}{3 \times 10^{8}}$$

$$h = 5089.23 \times 10^{-37}$$

$$h = 5.08 \times 10^{-34} \text{ J.sec.}$$


Scale -
on x-axis 1 unit = 0.001 × 10⁻⁴ K⁻¹
on y-axis - 1 unit - 0.02 log θ
1/T × 10⁴ →
log θ ↑

Date

Expt. No.

R_D - resistance of bulb filament at dropper point T_D.

$R_R = R_D \left(\frac{T_R}{800}\right)^{1.2}$

$T = T_R \left(\frac{R_T}{R_R}\right)^{0.833}$

where $T_D = 800k$ and $T_0 = 273k$

Observation table-

I (Ampere)	V (volt)	$R_T = V/I$	$T = T_R (R_T/R_R)^{0.833}$	Deflection of θ (nanometer)	1/T	$\log_{10}\theta$
1.25	3.0	2.40	520.016	3.32	0.0019	0.52
1.35	3.5	2.59	554.08	3.45	0.0018	0.53
1.44	4.0	2.77	585.98	3.60	0.0017	0.55
1.52	4.5	2.96	619.27	3.83	0.0016	0.58
1.61	5.0	3.10	643.58	4.09	0.0015	0.61
1.62	5.5	3.25	663.42	4.40	0.0014	0.64

Result-

Planck's constant - 5.08×10^{-34} J.sec.

Actual value of Planck's constant = 6.624×10^{-34} J.sec.

Precautions-

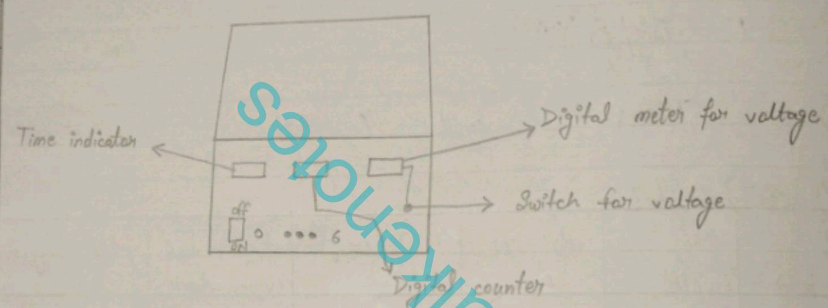
1. The instrument should be placed as near to the source as possible.
2. Cable system should be made as rigid and vibration free as possible.

Naina Lakhatar 2/04/2021

Teacher's Signature :

Wonder

Front Panel



Black panel

Object - To study the characteristics of the Geiger - Muller (G.M.) counter and hence to determine its operating voltage.

Apparatus - Triod Geiger counting, GM tube and a radio active source.

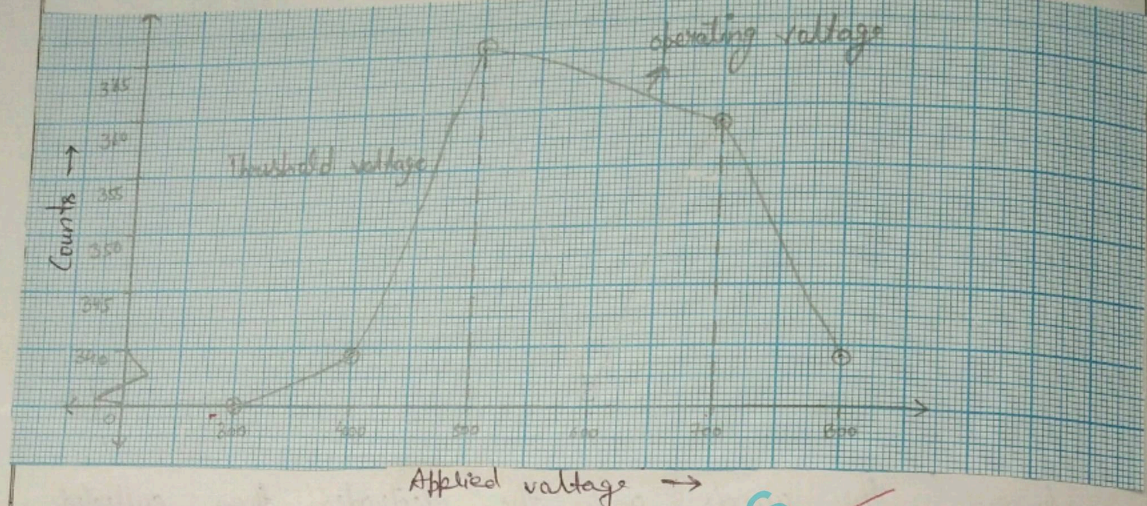
Theory - When a γ-ray enter the gas filled G.M. tube, it ionises the gas inside it & the electric field applied between the electrodes, drifts the electrons towards the anode and the electrodes thus collected at the anode are counter for barriars applied voltage using Geiger counting system. A graph is plotted for applied for voltage v/s connected counts & hence the operating voltage is determined from the graph.

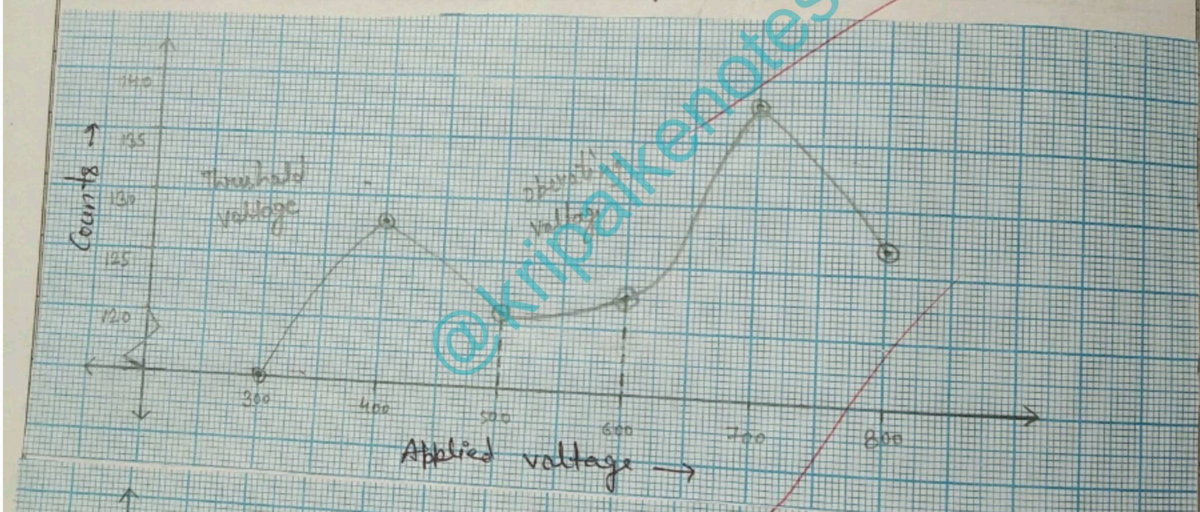
Push Switch -

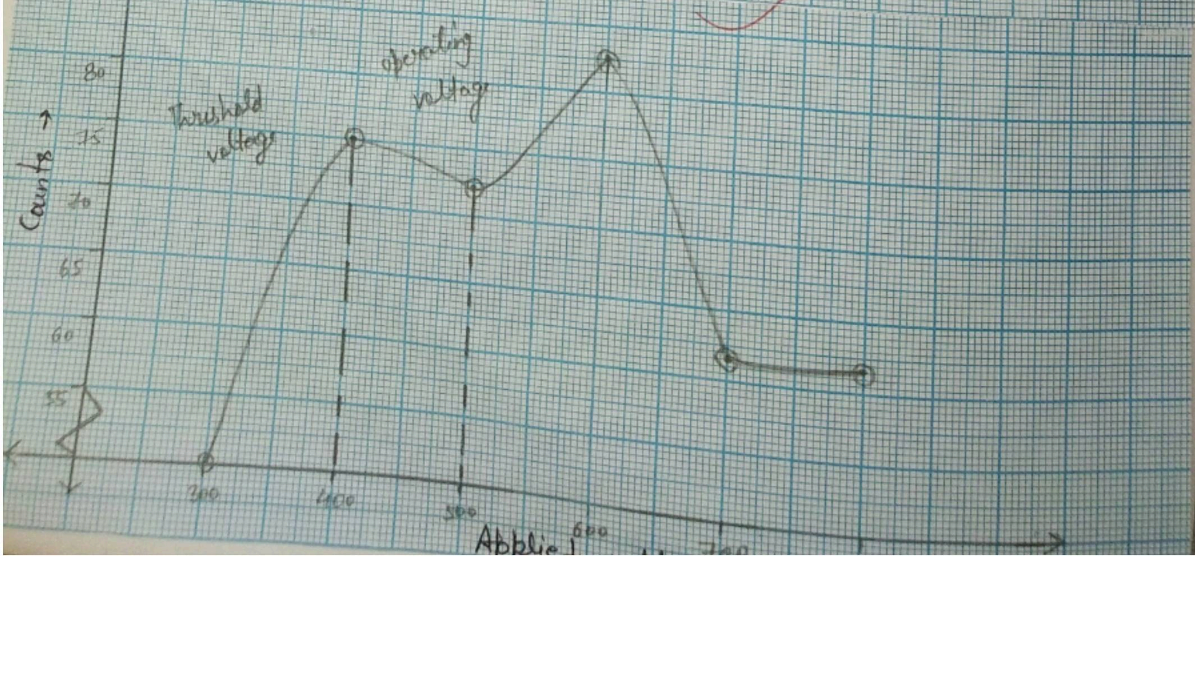
(i) Reset - As soon as this switch is pressed for 1 sec. The counter set to zero and ready to take fresh readings. Press the switch so that any reading stored is washed out. Press reset switch for 5sec. for old readings.

(ii) Start - This will start counting system only after pressed.

(iii) Stop - This will stop the counting process if needed for critical stop.


operating voltage
Threshold voltage
Counts →
Applied voltage →


Threshold voltage
operating voltage
Counts →
140
135
130
125
120
300
400
500
600
700
800
Applied voltage →


Threshold voltage
operating voltage
Counts →
80
75
70
65
60
55
300
400
500
600

Date ....

Page No. 10

Expt. No. ....

Observation table —

S.No.	Applied voltage (V volts)	Counts for 30 sec. with N/ (3cm) without radioactive element (N_B)		Correct counts ($N - N_B$)
		0	0	0
1	300	354	15	339
2	400	376	10	366
3	500	342	10	332
4	600	368	10	358
5	700	349	11	338
6	800			

At 5cm —

S.No.	Applied voltage (V volts)	N	N_B	$N - N_B$
		0	0	0
1	300	143	15	128
2	400	131	10	121
3	500	129	10	119
4	600	148	10	138
5	700	138	11	127
6	800			

At 7cm —

S.No.	Applied voltage (V volts)	N	N_B	$N - N_B$
		0	0	[illegible]
1.	300	90	15	75
2.	400	82	10	72
3.	500	93	10	83
4.	600	72	10	62
5.	700	73	11	62
6.	800			

Result –

Operational voltage of GM tube – 400 volt

Range of α- particle is shown in graph.

Precautions –

1. Handle the GM counter / ditector with extreme care.
2. Do not touch the end window with finger during practical.
3. Do not touch GM tube.

Nainvilkhalore
02-04-2021

Object – To determine the Plank's constant (h) by solar cell photovoltaic cell – selenium type) and three optical filters with the help of wien's radiation law.

Apparatus – Solar cell, optical bench with four stands, three different colour optical fibre, 0-6V DC at 3A, power supply with coarse and fine voltage control with two digital panel meters, DC microammeter (DC 65mm round dial mounted on bakellite stand) range 0-50 μA, one lamp with lamp house and one lens.

Theory –
We know that, According to wien's radiation law

$$dE = \frac{K}{\lambda^5} e^{-a/\lambda T} d\lambda \quad \text{—(i)}$$

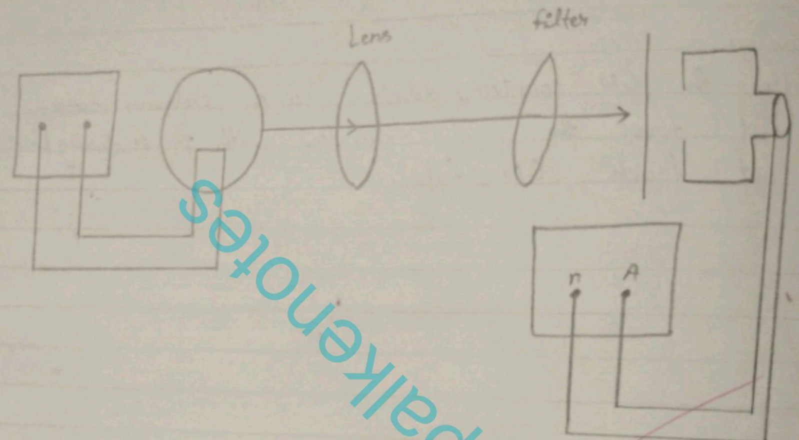
where K and a are constants.
According to Plank's law

$$dE = \frac{8\pi hc}{\lambda^5 (e^{hc/k\lambda T} - 1)} d\lambda \quad \text{—(ii)}$$

Relevant Theory –
for a black body at a temperature T, the emission in the range λ to $(\lambda + d\lambda)$ is given by

$$E_\lambda d\lambda = \frac{A}{\lambda^5} \{\exp(hc/\lambda kT) - 1\}^{-1} d\lambda$$

if $\frac{hc}{\lambda kT} >>> 1$ then $\exp\left(\frac{hc}{\lambda kT}\right) >>> 1$


Lens
filter
n
A

$$E_\lambda d\lambda = \frac{A}{\lambda^5} \exp\left(\frac{-hc}{\lambda KT}\right) d\lambda \quad \text{— (iii)}$$

where A- depend on size, h- plank's constant
If light is passed through a filter, with the most effective transmittance at and falls on a solar cell to give a microammeters response I, we have –

$$I = (At \cdot r) \frac{1}{\lambda^5} \exp\left(\frac{-hc}{\lambda KT}\right) \quad \text{— (iv)}$$

where t = constant, r = constant for solar cell.

$$I = B_\lambda \exp\left(\frac{-hc}{\lambda KT}\right) \quad \text{— (v)}$$

$\frac{Atr}{\lambda^5} = B_\lambda$ constant for fixed λ.

Taking log both side

$$\log_{10} I = \log_{10} B_\lambda - \frac{1}{2.303} \frac{hc}{\lambda KT} \quad \text{— (vi)}$$

$\because$ $Y = C - mx$ equation of straight line

So slope $\frac{\Delta \log_{10} I}{\Delta (1/T)} = \frac{1}{2.303} \frac{hc}{\lambda K}$

$$h = \frac{2.303 \lambda K}{c} \frac{\Delta \log_{10} I}{\Delta (1/T)} \quad \text{— (vii)}$$

where,

$C = 3 \times 10^8$ m/sec

K = boltzmann constant $= 1.38 \times 10^{-23}$ J/K

λ = effective wavelength used

$\lambda_{Blue} = 455$ nm $\quad \lambda_{green} = 510$ nm $\quad \lambda_{red} = 700$ nm

Calculation –

for red filter –

$$m = \frac{\Delta \log I}{\Delta(1/T)} = \frac{0.125}{0.0001} = 0.125 \times 10^{4}$$

$$h = \frac{0.125 \times 10^{4} \times 2.303 \times 1.38 \times 10^{-23} \times 700 \times 10^{-9}}{3 \times 10^{8}}$$

$$h = 95.34 \times 10^{-36}$$

$$h = 0.95 \times 10^{-34} \text{ J sec}$$

for Green filter –

$$m = \frac{0.2341}{0.00011} = 2128.18$$

$$h = \frac{2128.18 \times 2.303 \times 1.38 \times 10^{-23} \times 540 \times 10^{-9}}{3 \times 10^{8}}$$

$$h = 121745.71 \times 10^{-40}$$

$$h = 1.217 \times 10^{-34} \text{ J.sec.}$$

for Blue filter –

$$m = \frac{0.23}{0.0001} = 0.23 \times 10^{4}$$

$$h = \frac{0.23 \times 10^{4} \times 3.303 \times 1.38 \times 10^{-23} \times 480 \times 10^{-9}}{3 \times 10^{8}}$$

$$h = 116.95 \times 10^{-36}$$

$$h = 1.16 \times 10^{-34} \text{ Jsec}$$

Dropper point —

The dropper point is the temperature at which filament of bulb just glows.

$T_D = 527°C = 800K$

$T_0 = 0°C = 273K$

$R_D = \frac{V_D}{I_D}$ — V_D: Dropper voltage, I_D: Dropper current —— (VIII)

By this $R_R = R_D \left(\frac{T_R}{800}\right)^{1.2}$ —— (IX)

And by using $\frac{R_T}{R_R} = \left(\frac{T}{T_R}\right)^{1.2}$

$T = T_R \left(\frac{R_T}{R_R}\right)^{0.833}$ —— (X)

where, T_R = Room temperature (300K)

R_R = Resistance of room temperature [from eq. (IX)]

R_T = Resistance of filament

Observation table —

$I_D = 0.96A$

$V_D = 0.7V$

$R_D = \frac{0.7}{0.96} = 0.72916\ \Omega$

$R_R = R_D \left(\frac{T_R}{800}\right)^{1.2}$

$= 0.729 \times \left(\frac{300}{800}\right)^{1.2}$

$= 0.308\ \Omega$

Calculation–

(1) $V_T = 1.50$, $I_T = 1.22$, $R_T = \frac{V_T}{I_T} = \frac{1.50}{1.22} = 1.2295\ \Omega$

$$T = \left[T_R\left(\frac{R_T}{R_R}\right)^{0.833}\right]$$

$$T = 300\left(\frac{1.229}{0.308}\right)^{0.833} = 949.8\ K$$

$$1/T = 1/949.8 = 10.5 \times 10^{-4}\ K^{-1}$$

(2) $R_T = \frac{2.50}{1.58} = 1.5822$

$$T = 300\left(\frac{1.582}{0.308}\right)^{0.833} = 992.4\ K$$

(3) $R_T = \frac{3.50}{1.85} = 1.891$

$$T = 300\left(\frac{1.891}{0.308}\right)^{0.833} = 1360.2\ K$$

(4) $R_T = \frac{4.50}{2.11} = 2.132$

$$T = 300\left(\frac{2.132}{0.308}\right)^{0.833} = 1503\ K$$

(5) $R_T = \frac{5.50}{2.33} = 2.360$

$$T = 300\left(\frac{2.360}{0.308}\right)^{0.833} = 1635.9$$

(6) $R_T = \frac{1.40}{1.22} = 1.147$

$$T = 300\left(\frac{1.147}{0.308}\right)^{0.833} = 896.7$$

(7) $R_T = \frac{2.40}{1.54} = 1.558$

$$T = 300\left(\frac{1.558}{0.308}\right)^{0.833} = 1157.4$$

(8) $R_T = \frac{3.40}{1.82} = 1.868$

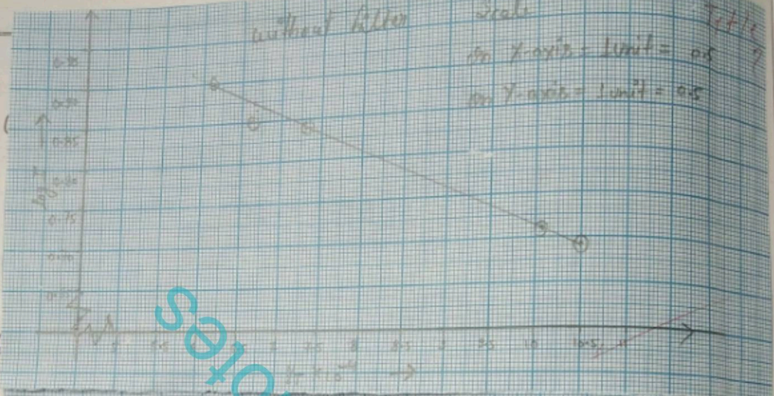
$$T = 300\left(\frac{1.868}{0.308}\right)^{0.833} = 1346.4$$

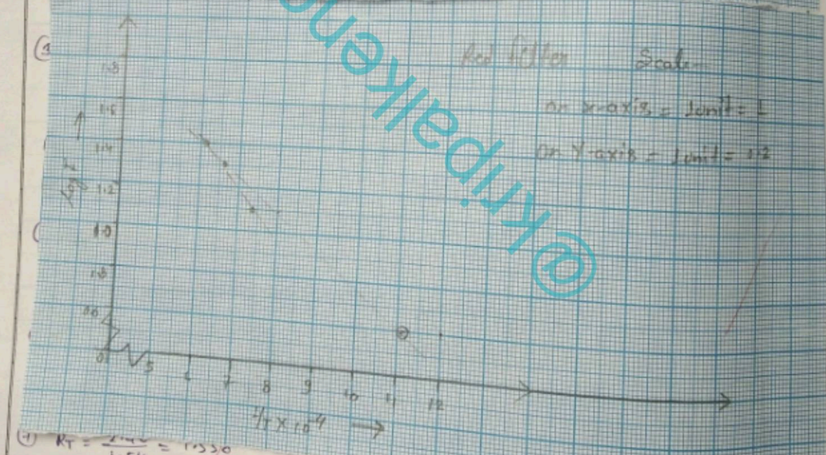
(9) $R_T = \frac{4.40}{2.08} = 2.115$

$$T = 300\left(\frac{2.115}{0.308}\right)^{0.833} = 1493.1$$

(10) $R_T = \frac{5.40}{2.30} = 2.347$

$$T = 300\left(\frac{2.347}{0.308}\right)^{0.833} = 1628.4$$





(7) $R_T = \frac{\ldots}{1.54} = 1.558$

$T = 300\left(\frac{1.558}{0.308}\right)^{0.833} = 1157.4$

(8) $R_T = \frac{3.40}{1.82} = 1.868$

$T = 300\left(\frac{1.868}{0.308}\right)^{0.833} = 1346.4$

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Without filter –

S.No.	V_T (V)	I_T (A)	I (µA)	R_T	T(K)	1/T	$\log_{10} I$
1.	1.50	1.22	5.3	1.229	949.8	10.5×10^{-4}	0.72
2.	2.50	1.58	6	1.582	992.4	10.07×10^{-4}	0.77
3.	3.50	1.85	7	1.891	1360.2	7.3×10^{-4}	0.84
4.	4.50	2.11	7.1	2.132	1503	6.6×10^{-4}	0.85
5.	5.50	2.33	8	2.360	1635.9	6.1×10^{-4}	0.90

Red filter –

S.No.	V_T (V)	I_T (A)	I (µA)	R_T	T(K)	1/T	$\log_{10} I$
1.	1.40	1.22	5	1.147	896.7	11.1×10^{-4}	0.6989
2.	2.40	1.54	5	1.558	1157.4	8.6×10^{-4}	0.6989
3.	3.40	1.82	15	1.868	1346.8	7.4×10^{-4}	1.1760
4.	4.40	2.08	20	2.115	1493.1	6.6×10^{-4}	1.3010
5.	5.40	2.30	30	2.347	1628.4	6.1×10^{-4}	1.4771

Green filter –

S.No.	V_T (V)	I_T (A)	I (µA)	R_T	T(K)	1/T	$\log_{10} I$
1.	1.40	1.20	5	1.166	909.3	10.9×10^{-4}	0.6989
2.	2.40	1.53	7	1.568	1163.7	8.5×10^{-4}	0.8450
3.	3.40	1.82	12	1.868	1346.4	7.4×10^{-4}	1.0791
4.	4.40	2.07	20	2.125	1499.1	6.6×10^{-4}	1.3010
5.	5.40	2.30	32	2.347	1628.4	6.1×10^{-4}	1.5051

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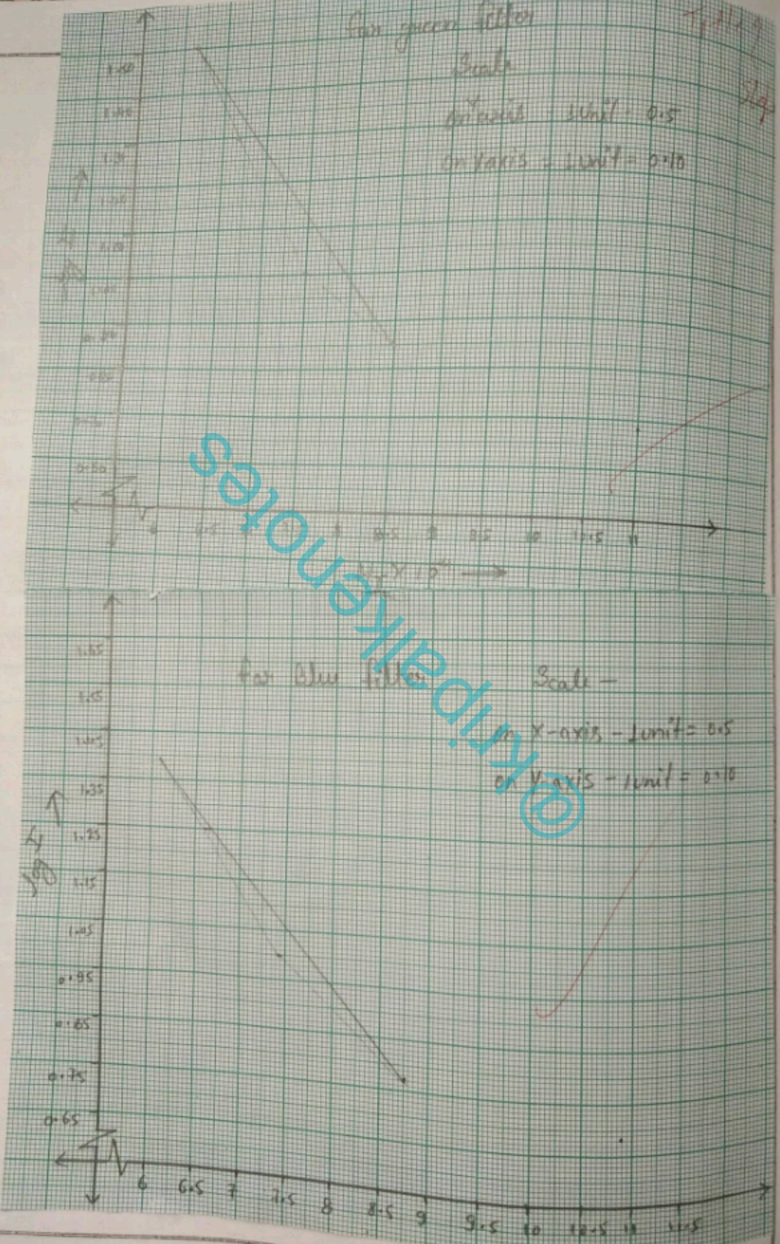
For green filter
Scale
On X-axis - 1 unit = 0.5
On Y-axis - 1 unit = 0.10
For blue filter
Scale -
On X-axis - 1unit = 0.5
On Y-axis - 1unit = 0.10

Blue filter –

S.No.	$V_T (V)$	$I_T (A)$	$I (\mu A)$	R_T	$T(K)$	$1/T$	$\log_{10} I$
1.	1.40	1.20	5	1.166	509.3	10.9×10^{-4}	0.69
2.	2.40	1.54	6	1.558	1137.9	8.7×10^{-4}	0.77
3.	3.40	1.83	10	1.857	1339.8	7.4×10^{-4}	1
4.	4.40	2.09	18	2.105	1487.1	6.7×10^{-4}	1.25
5.	5.40	2.33	39	2.317	1611	6.2×10^{-4}	1.39

Result –

Value of Planck's constant.

for Red – 0.95×10^{-34} J.sec.

for Green – 1.21×10^{-34} J.sec

for Blue – 1.16×10^{-34} J.sec.

Precautions! ?

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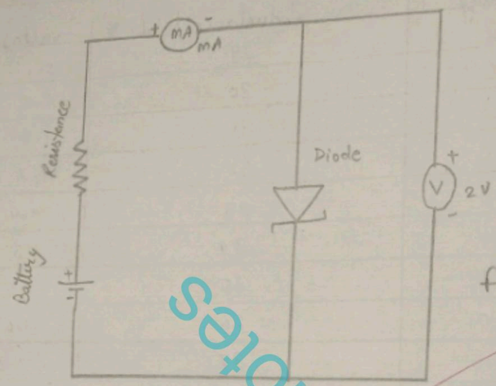
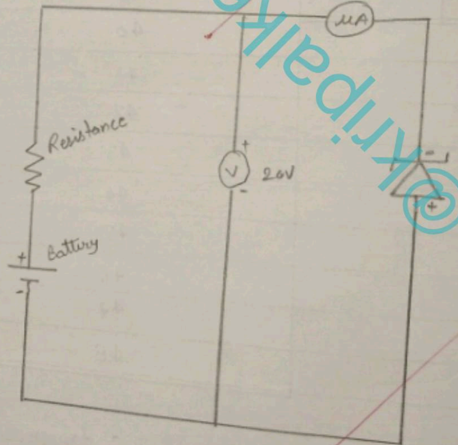
Circuit Diagram



forward Bias



Reverse Bias

Object - To study and plot the forward and reverse bias (Breakdown) Characteristic zener diode.

Apparatus required —

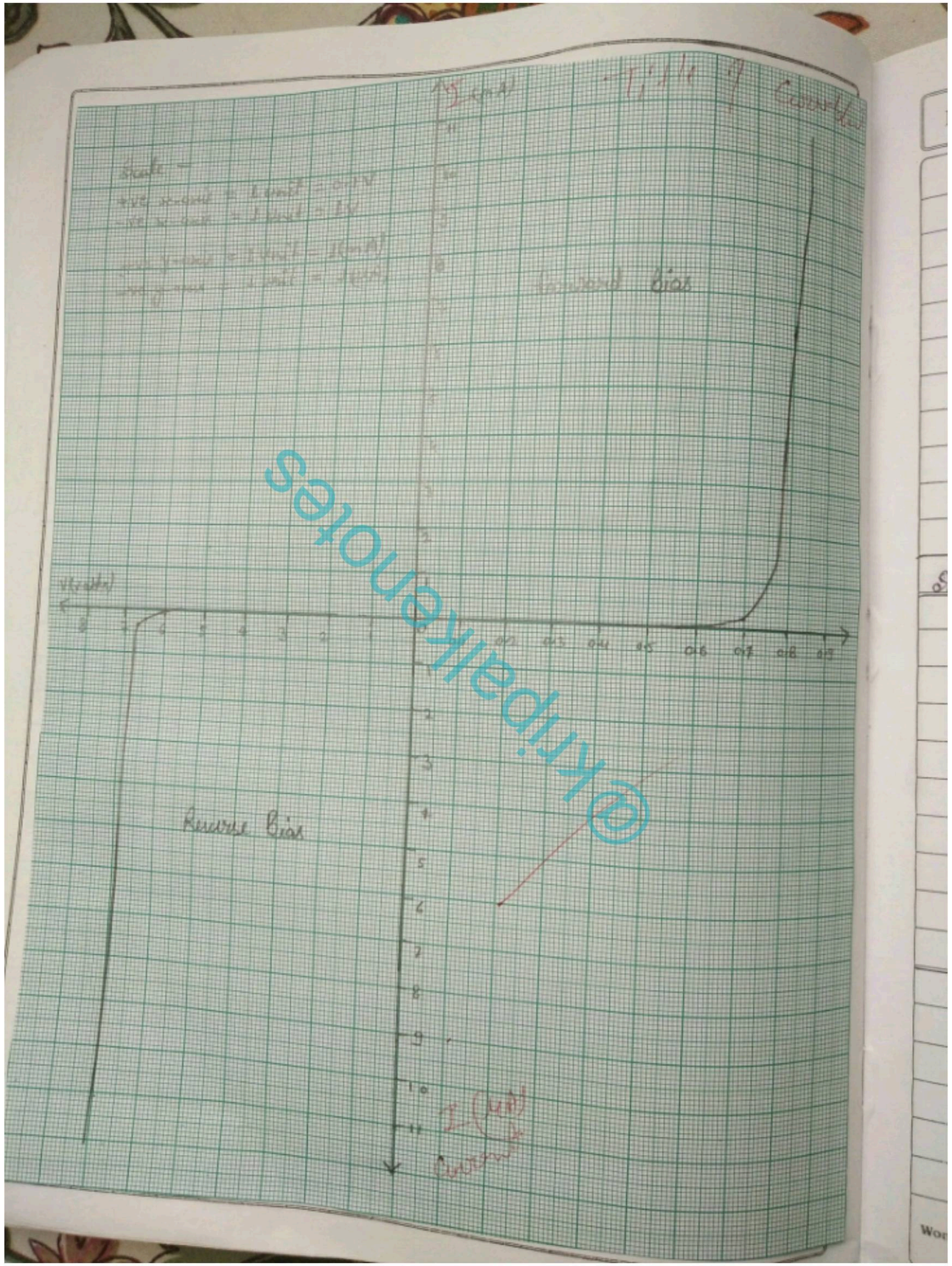
Junction and zener diode, a low current, low voltage, d.c. source, battery eliminator of 0.15 volt, a milliammeter and a micro-ammeter of suitable ranges rheostat, Patch chords. etc.

Theory —

Zener diode is a silicon diode that the manufacturer has optimised for operation in the breakdown region. It is the backbone of voltage regulation circuit that holds the load voltage almost constant despite large change in line voltage and load resistance.

In principle, if certain portion of I-V characteristic of any circuit element is such that inspite of change in voltage, current remains constant or inspite of change in current, voltage remains same i.e. the dynamic resistance becomes almost zero or infinity then such circuit elements can be used as voltage or current regulating circuit elements.

Since I-V characteristics of a zener diode in the breakdown region and output characteristics of common base transistor are of this nature, hence these can be used for regulation. Here we have described and study of zener diode I-V characteristics.


Forward Bias
Reverse Bias

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for reverse biased characteristics of zenerdiode, almost no current flows through the diode till the zener voltage of the diode is reached at which there is a sudden increase in the current with the increase in applied voltage. The voltage across the diode remains constant at its zener voltage.

Observation Table —

1. for forward bias characteristics.

S.No.	V (volts) at 2V	I (current) at 20 mA
1.	0.1	0
2.	0.2	0
3.	0.3	0
4.	0.4	0
5.	0.5	0
6.	0.6	0
7.	0.7	0.2
8.	0.8	6.30
9.	0.83	16.00
10.	0.85	18.65

2. for Reverse bias characteristics —

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S.No.	V (voltage) at 20V.	I (current) at 20 uA
1	1	0
2	2	0
3	3	0
4	4	0
5	5	0
6	6	0
7	6.50	0.01
8	6.60	0.03
9	7	15.36

Result – The forward and reverse bias breakdown characteristics of a zener diode as shown in graph.

Precautions of sources of error –

(i) Meters of proper range and least count should be used to measure forward and reverse currents.

(ii) The reverse voltage should not be increased beyond a certain limit otherwise current will suddenly increase and junction would be damaged permanently.

Nainy Lakhatia
02-04-2024

Date

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Object – Application of operational amplifier
(a) Inverting amplifier
(b) Non - inverting amplifier.

Apparatus required – Operational amplifier, audio frequency oscillator, direct voltage supply, AC input signal, connecting wires etc.

Theory and formula –

(a) Inverting amplifier –

Ratio of feedback resistance to input resistance is gain of amplifier.

$$Gain = \frac{-R_f}{R_{in}} = \frac{-10K}{1K} = -10$$

where, $R_f = 10 K\Omega$

$R_{in} = 1 K\Omega$

The amplifier has infinite gain. It will develop its output voltage 'E_o' with zero input voltage since the differential input voltage 'E_{in}' / R_{in} making the statement current

$$I_{in} = \frac{E_{in}}{R_{in}}$$

Also since, $I_i = 0$ due to infinite input impedance, the input current must flow in R_f and the output voltage E_o, then,

$$I_f = -\frac{E_o}{R_f}$$

$$\frac{E_{in}}{R_{in}} = \frac{-E_o}{R_f}$$

Wonder

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This equation may be restated in form of gain.

$$\frac{E_o}{E_{in}} = -\frac{R_f}{R_{in}}$$

The gain of inverting amplifier can be valued, by adjusting either R_f or R_{in} is varied from 0 to ∞. The gain also vary from 0 to ∞

Thus

I_f = finite for any value of R.

$R_{in} = 1K$

$R_f = 10k$

2. Non-inverting amplifier —

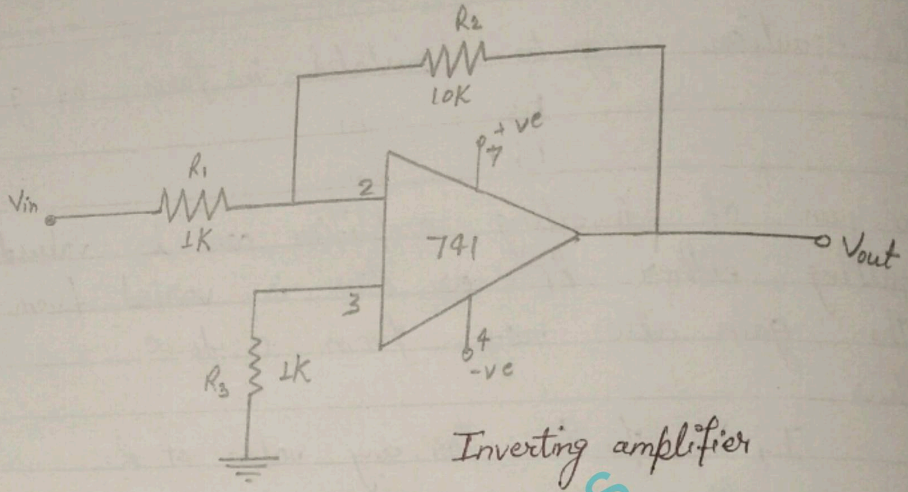
In non-inverting amplifier, input is applied to non-inverting input terminal and gain can be adjusted by changing feedback resistance.

Here, it is designed for a gain of 10.

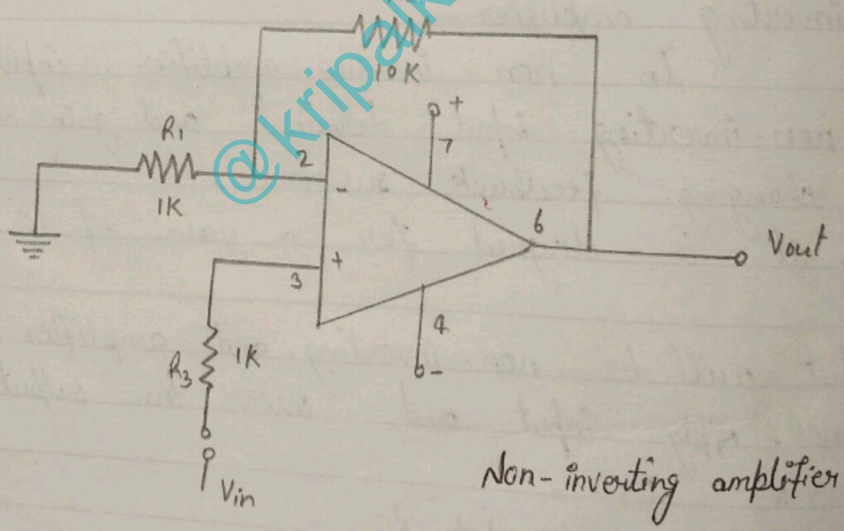
Output will be non-inverting and amplifier, by approximately 10 times. Apply input and observe the output apply 0.1 V to 0.3 V D.C.

$$V_o = V_{in} = 1 + \frac{R_f}{R_{in}}$$

$R_{in} = 1K$, $R_f = 10K$



Inverting amplifier



Non-inverting amplifier

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Observation Table –

Inverting Amplifier (Gain) –

S.No.	Vin (volt)	Vout (volt)	Gain = Vout/Vin
1	0.10	1.02	10.20
2.	0.30	3.05	10.16
3.	0.40	4.01	10.25
4.	0.50	5.00	10.00
5.	0.60	6.02	10.03
6.	0.70	7.17	10.24
7.	0.80	8.10	10.12

Non - inverting Amplifier (Gain) –

S.No.	Vin	Vo	Gain = Vo/Vin
1	0.10	1.18	11.8
2	0.20	2.27	11.3
3	0.30	3.39	11.3
4	0.40	4.40	11.0
5	0.50	5.52	11.04
6	0.60	6.66	11.1
7	0.70	7.74	11.05

Result – The voltage gain feedback for inverting & non-inverting.

Precautions –
Power supply should be connected with correct polarity.

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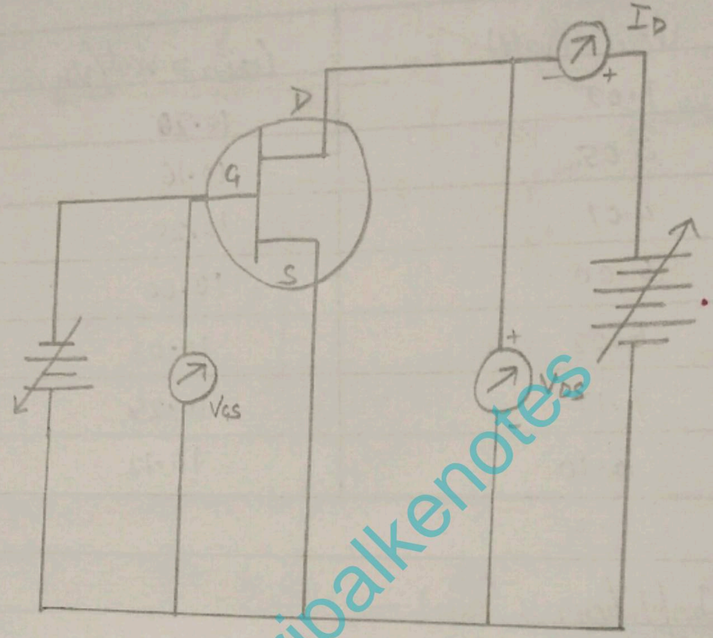


FET characteristics

V_{GS} = Gate source voltage

I_D = Drain current

V_{DS} = Drain source voltage

G = Gate

D = Drain

S = Source

Object - Study of field effect transistor characteristics.

Apparatus required - FET, voltmeter, ammeter, D.C power supply, connecting wires.

Theory and formula -

FET has high input impedance and field effect transistor to control the current by application of an electric field across the conducting region since it is called unipolar device.

FET is semiconductor device which has 3 terminal gate (G), source (S) and drain (D).

FET consists of small bar of n- semiconductor and has (-ve) terminal of source and the terminal drain is a heavily doped gate electrode G of P material from junction on each side of bar- region between the junction is called channel.

The electrons flow from source to drain through a channel between the depletion layer hence in such a device the current increase up to a certain limit to the pinch off voltage.

$$\text{Drain Resistance } R_{ds} = \left| \frac{\Delta V_{ds}}{\Delta I_{ds}} \right|_{V_{GS} = \text{constant}}$$

$$\text{Transconductance for } g_m = \left| \frac{\Delta I_{DS}}{\Delta V_{GS}} \right|_{V_{DS} = \text{constant}}$$

Calculation -

1.) Drain resistance (r_{DS}) -

$$r_{DS} = \left(\frac{\Delta V_{DS}}{\Delta I_{DS}}\right)_{V_{GS}} = \text{Constant}$$

$$r_{DS} = \frac{1}{1.5} \times 10^3 = 0.66 \times 10^3 \Omega$$

2.) Trans conductance (g_m) -

$$g_m = \left(\frac{\Delta I_{DS}}{\Delta V_{GS}}\right)_{V_{DS}} = \text{Constant}$$

$$g_m = \frac{1.5}{0.2} \times 10^{-3} = 7.5 \times 10^{-3} \Omega$$

3.) Amplification factor (μ) -

$$\mu = r_{DS} \times g_m$$

$$= 0.66 \times 10^3 \times 7.5 \times 10^{-3} = 4.05$$

$$\mu = \left(\frac{\Delta V_{DS}}{\Delta V_{GS}}\right)_{I_{DS}} = \text{Constant}$$

$$\mu = \frac{6}{0.2} \simeq 30$$

The three terminal of FET are -

1. Source
2. Gate
3. Drain

Observation Table -

Table for I_D V/s V_{DS} for different fixed value of V_{GS}.

S.No.	V_{DS}(V)	Drain current I_D (in mA)						
		V_{GS} = 0V	V_{GS} = -0.5V	V_{GS} = -1V	-1.5V	-2V	-2.5V	-3V
1.	0	0	0.0	0	0.	0	0	0
2.	0.5	2.24	1.74	1.49	0.94	0.47	0.05	0.01
3.	1.0	4.01	3.08	2.30	1.43	0.62	0.06	0
4.	1.5	5.30	4.00	2.83	1.64	0.66	0.07	0
5.	2.0	6.13	4.55	3.07	1.73	0.68	0.07	0
6.	2.5	6.60	4.82	3.18	1.77	0.70	0.07	0

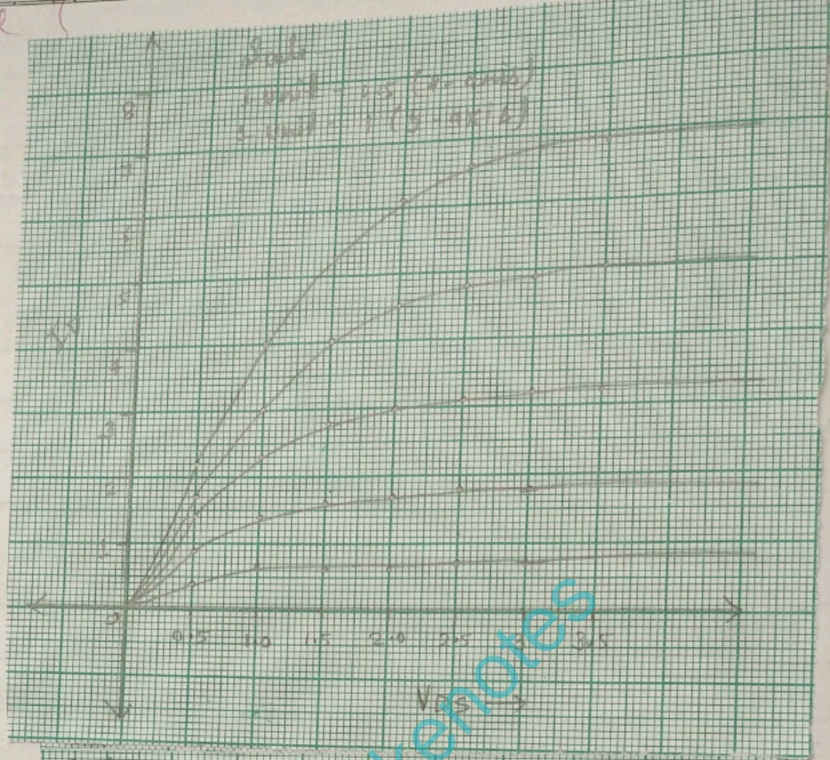
Note - Do not increase V_{DS} beyond 7 volts

Object 2.

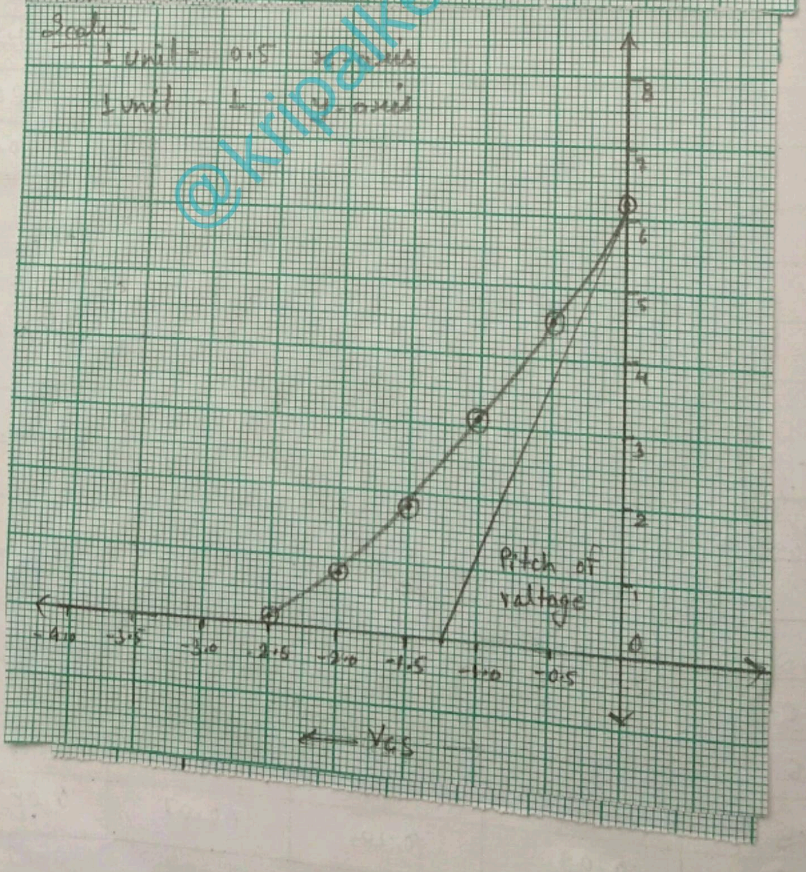
Drain current v/s gate bias characteristics.

S.No.	V_{GS} (v)	I_D (in mA)						
		V_{DS} = 18v	16v	12v	8v	4v	2v	1V
1.	0.0	6.25	6.40	6.53	6.60	6.86	5.96	4.05
2.	0.5	4.59	4.60	4.55	4.80	4.82	4.38	3.22
3.	1.0	3.17	3.13	3.15	3.30	3.20	3.00	2.39
4.	1.5	1.83	1.81	1.89	1.87	1.85	1.71	1.50
5.	2.0	0.76	0.78	0.60	0.70	0.74	0.68	0.62
	2.5	0.10	0.11	0.07	0.09	0.09	0.09	0.6

Title ?


Scale
0.5
1.0
1.5
2.0
2.5
3.5
VDS →

Title ?


Scale
1 unit = 0.5 x-axis
1 unit = 1 y-axis
8
6
5
4
3
2
1
0
-4.0
-3.5
-3.0
-2.5
-2.0
-1.5
-1.0
-0.5
Pitch of voltage
← VGS

Date

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Result-

The drain resistance r_{DS} = $0.66 \times 10^3 \Omega$

Trans conductance g_m = $7.5 \times 10^{-3} \Omega$

Amplification factor μ = 30

Pitch of valtage = -1.25

Precautions-

1. Readings should be taken properly.
2. Wires should be connected carefully.

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