II BSC SEMESTER-IV

MODERN PHYSICS

PRACTICAL MANUAL
(PAPER V)

2022-2023

Department of Physics
Sri Y.N.College (A)
Narsapur

1. Plank's Constant

Aim:-

To determine the value of plank's constant 'h' by a photo cell.

Apparatus:-

Photo emission cell, maintained in a box provided with a wide slot, Dc power supply, source of light filters.

Formula:-

$$h = \frac{e(V_2 - V_1)\lambda_1\lambda_2}{c(\lambda_1 - \lambda_2)} \text{ J/sec.}$$

where, e = electric charge = 1.6×10^{-19} coloumbs.

c = speed of light = 3×10^{10} cm/sec

V_1 = stopping potentials of corresponding to wave length with filter - I (volts)

V_2 = stopping potential of corresponding to wave length with filter - II (volts).

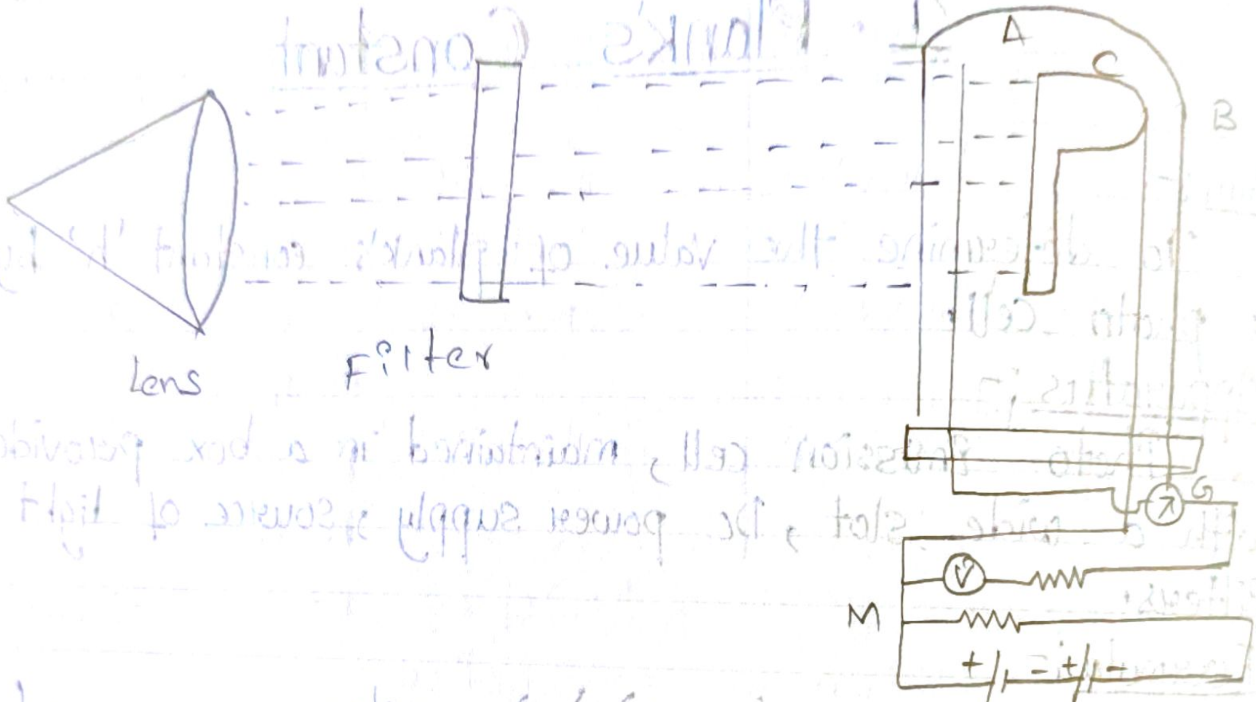
λ_1 = wave length of filter - I (cm)

λ_2 = wave length of filter - II (cm).

Procedure:-

make the connections are shown in figure. The positive terminal of the battery on this connected to cathodes and negative terminal to the cathode 'c' place the photo cell a distance d from the source of light 'L' surface on the appartus and ensure that the lamp. set

Signature :



Graph:-

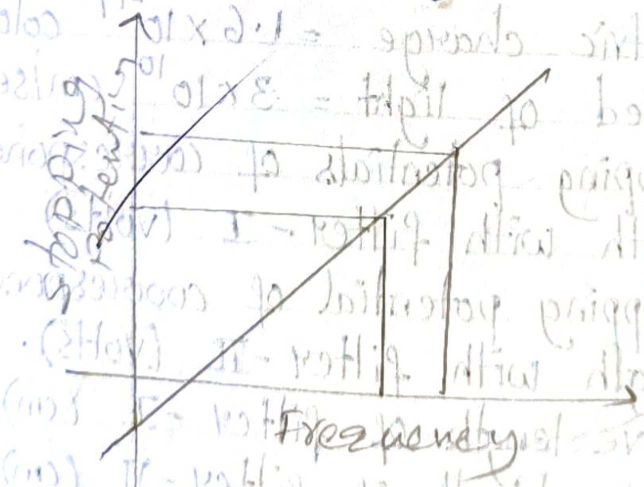


Table :- The observation are tabulated as shown below

S.No	colour of the filter	wavelength (λ) cm	frequency incident light (ν λ)	stopping potential in volts.
1.	Red	4400×10^{-8}	6.8×10^{14}	0.782
2.	Green	5200×10^{-8}	5.7×10^{14}	0.582
3.	Blue	6400×10^{-8}	4.68×10^{14}	0.257

the voltage sector to the position mark switch on the lamp adjust scale.

To determine the plank's constant (h) photo electric work function of the material of the cathodes:-

connect the circuit as shown in the place the light source 'L' on the windown w of the photo cell p. But not it take the volt filter and so shown window w provided to light box B. photo electric current is zero. This is negative potential current to zero is called the stopping potential.

Graph :-

Draw a graph with the frequency of v of the incident light on the x-axis and the correspondent stopping potential V_s on the Y-axis. A straight graph is as shown in Fig.

It is observed from the figure that the straight line cuts the frequency axis the intercept on the frequency axis.

h = slope of the straight line.

Precautions :-

1. The mercury vapour lamp optical fibre and the photocell should be placed on line.

2. The positions of lamp should not be destraped the Experiment

Result :-

The value of plank's constant from graph $h = 2.176 \times 10^{-34}$ J/sec

The value of plank's constant from table $h = 2.287 \times 10^{-34}$ J/sec

Signature :

2. Energy Gap Of A Semiconductor

Aim :- To determine the energy band gap of the semi conductor material taken in the form of an P-N junction diode.

Apparatus :- Dc power supply, Semi conductor diode, Thermometer, heating arrangement to head the diode, voltmeter, microammeter and connecting wires.

Formula :-

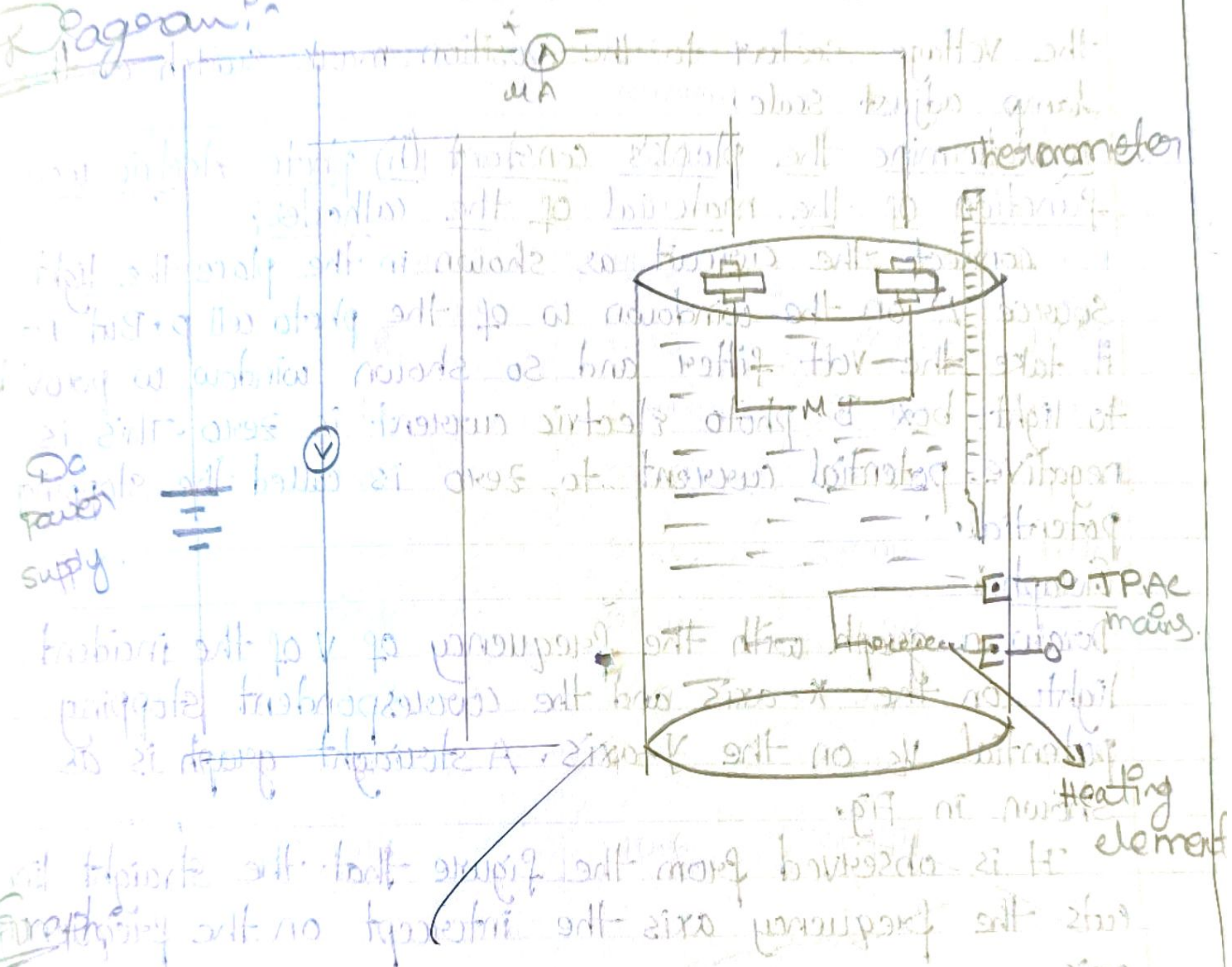
$$E_g = \frac{\text{slope of the straight line}}{5.036} \text{ e.v}$$

where, E_g = Energy band gap of given semi-conductor diode.
m = slope of the straight line plot against for $\log_{10} I_S$ and $10^3/T$
I_S = Reverse saturation current (μA).
T = Absolute Temperature (°K).

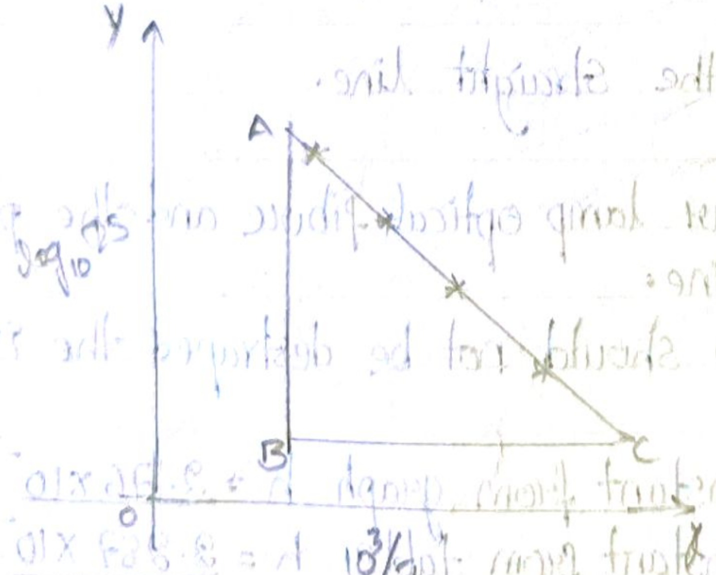
Description :-

The experimental arrangement compass on oil bath is provided with soclatus at its much. The soclates are used to insert the thermometer and the semi-conductor diode in the oil bath as shown in figure. A heating element is fixed inside the oil bath which is used to raise the temperature of the oil bath by connecting to A.c main supply. The reverse using voltage can be adjusted by mean of the voltmeter and the reverse saturation current can be measured with the help of micro ammeter.

Diagram:-



Graph:-



Procedure :-

Connect the two terminals of given semi conductour diode to the DC power supply and microammeter in such a way that the diode is reverse biased. inverse the diode in old bath. Insert the thermometer in the oil bath at the same level as that of diode.

Switch on the DC power supply and adjust the reverse biased voltage to tell 5 volt. switch on A.C main supply then the thermometer of oil bath gradually increases. when the temperature of oil bath will rix and stabilizers at the about 70°c. Note the temperature of the oil bath and the current through the diode. After few minutes the temperature of oil bath will begin to fall and the current through the diode decreases. Note the value of current four every 5°c decreases of the temperature till the temperature oil bath fall to the room temperature.

Graph :-

Draw a graph with $10^3/T$ on x-axis and $\log_{10} I_s$ on y-axis. The graph will be straight line as shown in the figure. From the semi conductor can be calculated by substituting the value of slope m in given equation.

The calculated value of Eg should be compared with the standard value. This experiment can also be performed four different reverse biased voltage.

Signature :

S.No	Temperature $t^{\circ}C$	$T = t + 273$	Current I_s μ	$\frac{10^3}{T}$ (K^S)	$\log_{10} I_s$
1.	80	353	96.5	2.832	1.984
2.	75	348	68.5	2.873	1.835
3.	70	343	51.0	2.915	1.707
4.	65	338	38.8	2.958	1.588
5.	60	333	29.3	3.000	1.466
6.	55	328	22.0	3.048	1.342
7.	50	323	16.9	3.095	1.227
8.	45	318	13.5	3.144	1.130
9.	40	313	10.6	3.194	1.025

Procedure :-

Connect the two terminals of given semi conductour diode to the DC power supply and microammeter in such a way that the diode is reverse biased. inverse the diode in old bath. Insert the thermometer in the oil bath at the same level as that of diode.

Switch on the DC power supply and adjust the reverse biased voltage to tell 5 volt. switch on A.c main supply then the thermometer of oil bath gradually increases. when the temperature of oil bath will rix and stabilizers at the about 70°c. Note the temperature of the oil bath and the current through the diode. After few minutes the temperature of oil bath will begin to fall and the current through the diode decreases. Note the value of current four Every 5°c decreases of the temperature till the temperature oil bath fall to the room temperature.

Graph :-

Draw a graph with $10^3/T$ on x-axis and $\log_{10} I_s$ on y-axis. The graph will be straight line as shown in the figure. From the semi conductor can be calculated by substituting the value of slope m in given Equation.

The calculated value of Eg should be compared with the standard value. This experiment can also be performed four different reverse biased voltage.

Signature :

Precautions :-

1. The diode and thermometer should be immersed at the same level in the oil bath.

2. The temperature and the current should be noted simultaneously.

3. The experiment should be performed by connecting the diode in the reverse biased position.

Result :-

The energy band gap of the given semi conductor material is E_g = 0.52 Electroing volt.

3. Determination Of M and H

Aim:- To determine the magnetic moment of the given magnet and the horizontal component of the earth's magnetic field at a plane.

Apparatus:- Deflection magnetometer, vibration magnetometer, magnet, a brass rod whose dimension are same as that the magnet, a stop-watch, vernier callipers and rough balance.

Formula:-

1. $$M/H = \frac{(d^2 - l^2)^2}{2d} \tan\theta$$

where, M = Magnetic moment of the given magnet.
H = Horizontal component of earth's magnetic field at a plane.
d = distance from the centre of the magnet to the centre of the needle.
l = Half of the length of the magnet.
θ = Average deflection of the aluminium pointer.

2. $$MH = \frac{4\pi^2}{T_2^2 - T_1^2} \times I$$

where T_1 = period of oscillation of the magnet.
T_2 = Period of oscillation of the magnet together with the brass rod.
I = Moment of inertia of the brass rod about the axis of rotation.

$$I = \frac{m(a^2+b^2)}{12}$$

where m = mass of the brass rod.
a = length of the brass rod.
b = breadth of the brass rod.

Description :-

1. Deflection Magnetometer :-

The Deflection magnetometer comprises a magnetic compass box. The magnetic compass box consists of a very small magnetic needle pivotol on a sharp suppourt at the centre of a circular scale is graduated in degree and divided into four equal. Each gaudraut is from 0°-90° so that the diameteric opposite points indicate the same reading. A circular plane mirrour is fixed just below the pointer which enables to take the readings of the pointer without error due to parallax. The needle the aluminium pointer and the circular are encased in a circular brass box with a glass tap to protect the needle from the doughts to air.

2. Vibration Magnetometer :-

It consists of a bellow rectangular wooden box B whose front surface is made of glass two openings S_1 and S_2 are provided at the top of the box. which are fitted with glass, by means of which the oscillation can be seen Along cylindrical glass tube A toursion lod H is fixed vertically at the middle of the top surface of the box.

A light brass strip is suspended by means of an unspun silk thread from the torsion head, H as shown in figure. The torsion bead can be rotated to adjust is set into the Oscillations.

Procedure :-

This experiment is to be performed in two parts.

1. To determine the value of (M/H) using deflection magnetometer.

Place the deflection magnetometer on the work table and remove all magnets and magnetic materials from the velocity of the magnetometer set the deflection magnetometer in such a way that the axes of the magnetometer are oriented in east-west director i.e., the arms of the magnetometer are parallel to the aluminium pointer and perpendicular to the magnetic needle Rotate the magnetic compass box until the ends of the aluminium pointer reads 0-0 on both sides of the circular scale.

Place the given magnet on the eastern arms of the magnetometer at a distance d from the centre of the magnetic needle so that the axial line of the magnet pass through the centre of the magnetic needle. Note the deflection θ_1 and θ_2 against the ends of the aluminium pointer on the circular coil keeping the magnet at the same distance.

Repeat the experiment by placing the magnet at other distances say (20, 22, 24 cm). Note the deflections in the table. Find the mean value of M/H using formula.

2. To determine the time periods T_1 and T_2 using the vibration magnetometer.

Place the vibration magnetometer on the work table level the instruments by means of the leveling screws, so that the thread from the torsion load H, line vertically without the inner surface of the cylinder place to given magnet alone on the stripping so that it hangs freely is the direction of the magnet meridian. Take another magnet and brought it near the box. Move the second magnet on the striprup is set into oscillations make another trail and note the time taken 20 oscillations. Find the mean time t_1 taken for 20 oscillation from this find the time period T_1.

Take a brass rod of the same dimensions as that of the given magnet and then place it in the striprup along with the magnet. Repeat the above procedure and find the time period T_2 Note observation in the table.

Final the mass, M of the brass rod with a rough balance find the length, a of the brass rod using a scale and its breadth, b using vernier callipers. The moment of inertia I_2 of the brass and can be calculated using the relation.

$$I = \frac{m(a^2+b^2)}{12}$$

Precautions:-

1. The suspension thread in the vibration magnetometer should be torsionless.
2. Deflection should be noted without parallax between the aluminium pointer.

Result:-

1. The magnetic moment of the given magnet
   M = 1407.459 C.G.S unity.
2. The horizontal component of earth's magnetic field.
   H = 0.3028 oersted unity.

S.No	Distance from the centre of the magnet to the centre of magnetic field (d) cm	Deflection of the aluminium pointer								Mean θ	Tan θ	$\frac{M}{H} = \frac{(d^2-l^2)^2}{2d} \tan\theta$
		magnet of the eastern arm				magnet of the western arm						
		Direct		reverse		Direct		Reverse				
		θ_1	θ_2	θ_3	θ_4	θ_5	θ_6	θ_7	θ_8			
1	[illegible]		[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

S.NO	material	Time taken for 10 oscillation of the magnets			Time period $T = t/10$	$T_2^2 - T_1^2$
		T_1	T_2	t		
1.	magnet	43	49	46	4.6	22.4
2.	Magnet + brass rod	67	65	66	6.6	

To determine the breadth (b) of the brass rod.

S.No	M.S.R	V.C	n×L.C	a+n×L.C
1.	1.3	6	0.06	1.36

To determine the length of the brass rod (a) :-

S.NO	M.S.R	V.C	nxL.C	a+nxL.C
1.	6.6	5	0.05	6.65
2.	6.6	5	0.05	6.65

6.65

To determine the length of magnets (L) :-

S.NO	M.S.R (a)	V.C (n)	nxL.C	a+nxL.C
1.	7.7	4	0.04	7.74

4. De-Morgans Theorem

Aim :- To verify De-Morgan's theorem in Boolean algebra.

Apparatus :-

One-OR gate, one AND gate, three NOT gates, batteries, connecting wires, a bread board and a DC voltmeter.

Formula :-

Theorem-1 :-

This theorem states that the complement of the sum of two or more variables is equal to the product of complement of individual variables.

$$\overline{A+B+C} = \overline{A} \cdot \overline{B} \cdot \overline{C}$$

Theorem-2 :-

This theorem states that the complement of product of two or more variables is equal to the sum of complements of individual variables.

$$\overline{A \cdot B \cdot C} = \overline{A} + \overline{B} + \overline{C}$$

Theory :-

The Inputs A and B and C are applied to an OR gate followed by a NOT gate give the output $Y_1 = \overline{A+B+C}$. This part of the circuit is called a NOR gate. The same inputs A, B and C are applied to three NOT gates to yield the outputs $\overline{A}$, $\overline{B}$ and $\overline{C}$ which are the inputs of an AND gate. The output of this last NAND gate is $Y_2 = \overline{A} \cdot \overline{B} \cdot \overline{C}$. The purpose

Signature :

of the experiment is to show that $Y_1 = Y_2$ four various combinations of A and B and c, these verifying the first statement.

The inputs A and B are fed to an AND gate followed by a NOT gate to an output $Y_1 = \overline{A+B+C}$. This put of the circuit is called a NOT, AND or NAND gate. the same inputs A and B and c are a fed to an OR gate. the output of this OR gate is $Y_2 = \bar{A}+\bar{B}+\bar{C}$. The purpose here is to show that $Y_1 = Y_2$ four different values of A and B and c. Thus verifying the second statement.

Procedure :-

To verify the statement (a) step up on a bread board of the circuit diagram for different combinations of high and low values of the inputs A and B and c. Measure the DC voltmeter the voltages measure simultaneously the output voltages Y_1 and Y_2. All voltages are to be measured with respect to common reference. The value of an input may be zero corresponding to a short circuit to ground while the value high of an input may be 5 volts apply by a battery.

To verify the second part of Demorgans theorem the circuit diagram is constructed on the bread board. Four different combinations high and low values of the inputs A and B and c the voltage are measured at points at the same time measure the output voltage

Signature :

Y_1 and Y_2 also the readings are tabulated.

Precautions :-

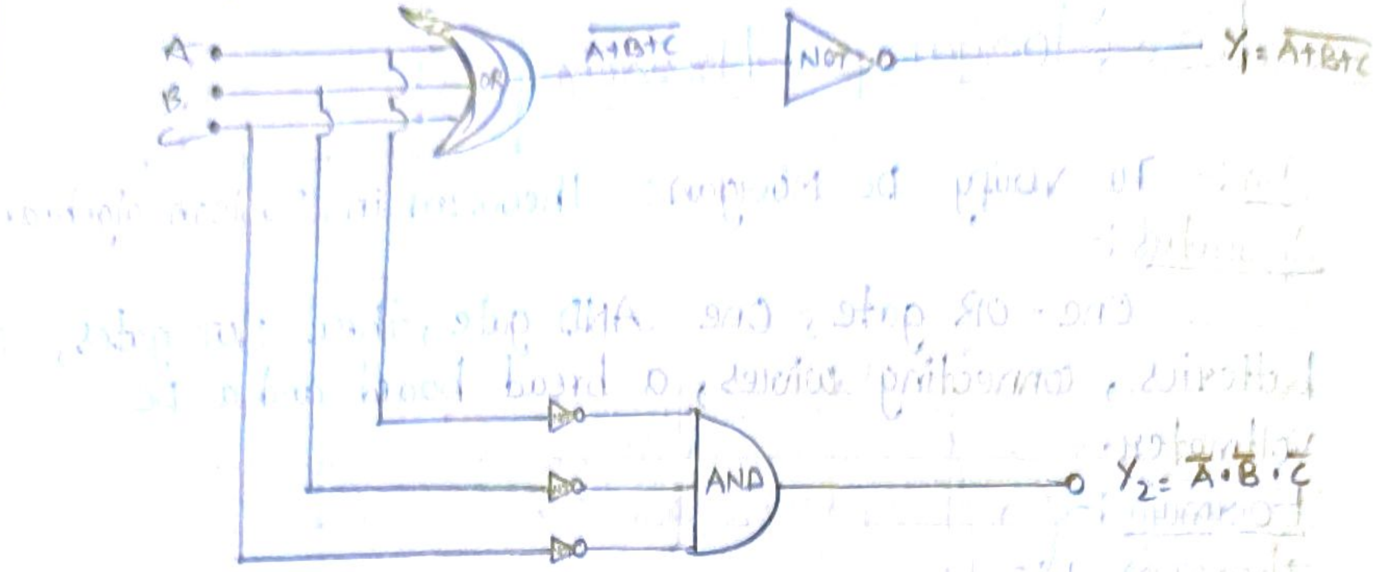
1. All the connections should be neat and tight.
2. check the power supply on.

Result :-

From the truth table, four different combinations of high and low values of the inputs A and B and c. $Y_1 = Y_2$ Demorgans first theorem is verified.

Since $Y_1 = Y_2$ four different combinations of high and low values of the inputs A and B and c is the truth table. De-Morgans second theorem is verified.

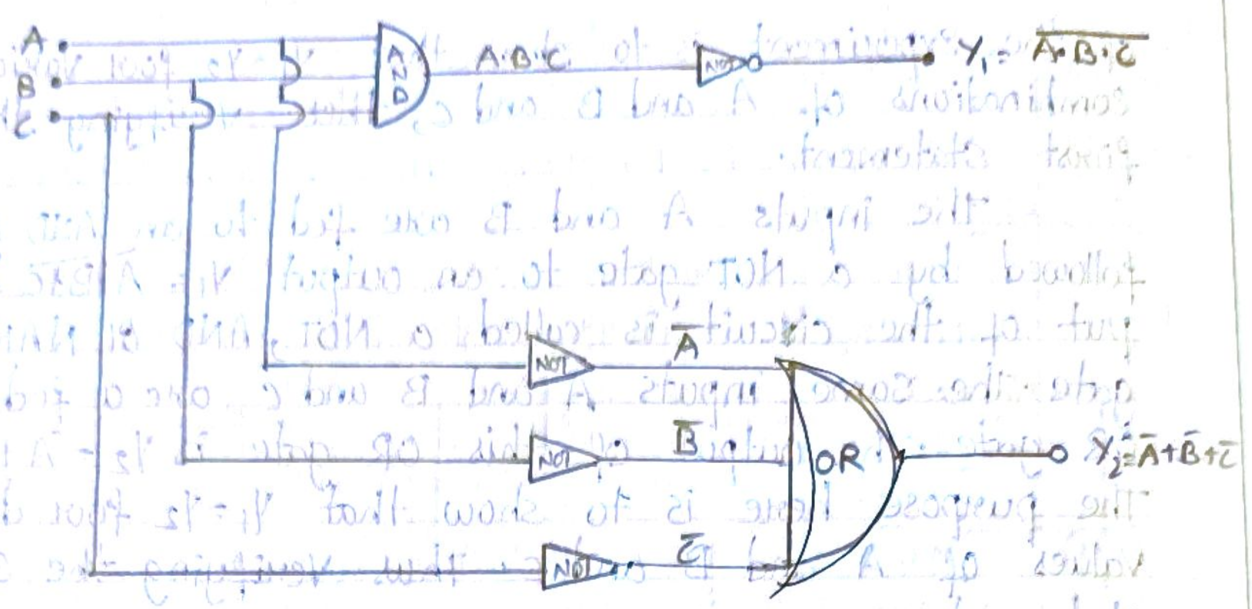
Circuit diagram for theorem-1:-



Truth table for theorem-1:-

A	B	C	$\overline{A}$	$\overline{B}$	$\overline{C}$	$Y_1 = \overline{A+B+C}$	$Y_2 = \overline{A}\cdot\overline{B}\cdot\overline{C}$
0	0	0	1	1	1	1	1
0	0	1	1	1	0	0	0
0	1	0	1	0	1	0	0
0	1	1	1	0	0	0	0
1	0	0	0	1	1	0	0
1	0	1	0	1	0	0	0
1	1	0	0	0	1	0	0
1	1	1	0	0	0	0	0

Circuit diagram for theorem - II :-



Truth table $\overline{A \cdot B \cdot C} = \bar{A} + \bar{B} + \bar{C}$

A	B	C	$\bar{A}$	$\bar{B}$	$\bar{C}$	$Y_1 = \bar{A}+\bar{B}+\bar{C}$	$Y_2 = \overline{A \cdot B \cdot C}$
0	0	0	1	1	1	1	1
0	0	1	1	1	0	1	1
0	1	0	1	0	1	1	1
0	1	1	1	0	0	1	1
1	0	0	0	1	1	1	1
1	0	1	0	1	0	1	1
1	1	0	0	0	1	1	1
1	1	1	0	0	0	0	0

6. Specific Charge (e/m) Of an Electron Thomson's Method

Aim :- To determine the value of specific charge (e/m) of an electron by Thomson's Method.

Apparatus :-
Cathode ray tube with its power supply unit pair of bar magnets, compass box, a wooden stand to place the bar magnets on its two arms with CR tube in the middle.

Description of the CR Tube :-
It consists of three basic components
1) Electron Gun :- which produces acceleraties and focuses emitted electrons into a narrow beam.
2) Deflecting system :- which deflects the electron beam either electrically (or) magnetically.
3) Flurosent screen :- upon which beam of electrons impinges to produce a visible spot.

Formula :-

$$e/m = \frac{V \times y \times 10^7}{lLH^2d} \text{ e.m.u/gm.}$$

where, l = length of the deflecting plate.
L = distance of screen from the centre of plates.
d = separation between the plates.
H = Horizontal component of earth's magnetic field.
V = deflecting voltage applied to the plate.
Y = deflecting of the spot on the screen under the magnetic field.
e/m = specific charge of the electron.

Signature :

Procedure :-

* Draw the north south line using a compass needle. Also draw the east west line, place the CRT fitted on the screen.

* Adjust the brightness and flows controls so as to get a sharp bright point spot in the middle of the screen. Note the initial position of the spot on the scale fitted on the screen.

* Now apply a suitable deflection voltage so that the luminous spot in deflection voltage so that the determination spot is deflected by about 0.5 to 1.0 cm. Now the deflection voltage spot has moved and let it be Y.

* place the bar magnet symmetrically, on either side of CRT along the arms wooden stand on which tube is fited such that opposite places of the magnet so that the spot come it's initial position.

when the adjustment is perfect not the distance of the magnet on the side nearer to the C.R.T.

* Remove the bar magnet, switch the electronic field applied to the deflecting plates and note to initial of the luminous spot. Help the reversing switch filled power supply. Note final position and calculate Y.

* To find the value of core to remove magnet and CRT from wooden stand place compass box with compass needle, such that its centre i.e., exactly on the point.

* place the magnets exactly in the position r_1, r_2, r_3 and r_4 which gives angle $\theta_1, \theta_2, \theta_3$ and θ_4.
* Take move sets of observation by changing the value of V and hence the electric field.

Precautions :-

1) Magnets magnetic substance or current carrying conductions should be kept away from the varying of the apparatus.
2) Deflections should be noted without parallex between the alluminium pointed and its image.
3). The magnetic should be place at the same height as that of the axis of CRT.
4) observations should be taken only after ensuring that the CRT is exactly in the magnetic meridian.

Result :-

These specific charge of electron (experimental value)
$e/m = 1.46 \times 10^7$ e.m.u/gm

Horizontal component of the earths magnetic field He = 0.38

Applied Potential	Position of electron beam		Deflection electron beam	mean distance of the magnet	Deflection in the magnetic needle				Mean	Tan	H = He	H^2
	Initial	Final	y = a - b		θ_1	θ_2	θ_3	θ_4	θ	θ	Tanθ	
2	0	0.1	0.1	28.25	26	26	24	23	24.75	0.46	0.1748	0.030
4	0	0.2	0.2	23.05	24	23	44	42	43.25	0.940	0.357	0.127
6	0	0.3	0.3	20.75	53	54	58	57	56	1.482	0.563	0.317
8	0	0.4	0.4	17.75	69	68	65	66	67	2.355	0.894	0.800
10	0	0.5	0.5	15.9	60	61	80	82	70.75	2.863	1.087	1.183
12	0	0.6	0.6	15.6	80	82	60	61	70.75	2.863	1.087	1.183

INSTRUCTION MANUAL

AIM:-

To verify the inverse square law of light using a photovoltaic cell.

APPARATUS:-

AElab Photovoltaic Cell, AElab Galvanometer (or a micro ammeter), Optical Bench with 2 riders and Lamp box

FORMULA USED:-

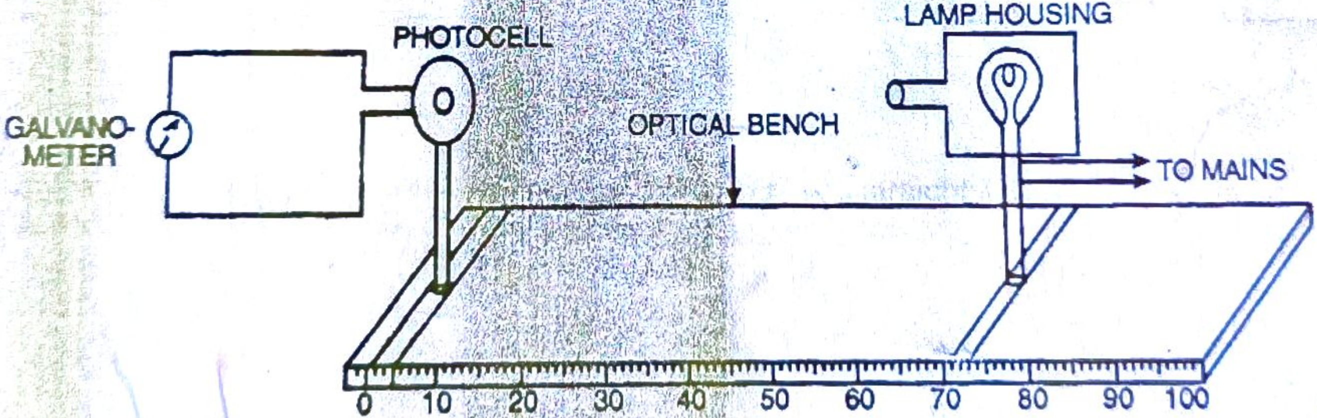
Inverse square law of light states that for a source of light having constant luminous intensity, the intensity of illumination (I) at a point on a surface in case of normal incidence is inversely proportional to square of distance (r) of that point from the source i.e.

$$I \propto \frac{1}{r^2}.$$

But the current through a photo-voltaic cell is directly proportional to the intensity of illumination. The galvanometer deflection Θ being proportional to current passing through it, we can write

$$\theta \propto I$$

$$\theta \propto \frac{1}{r^2}$$



PROCEDURE:-

1. Arrange the apparatus on the working table in a dark room according to scheme show in the fig. so that stray light falling on photovoltaic cell is avoided.
2. Adjust the heights of lamp housing and the photovoltaic cell so that these lie on the same horizontal level and light falls on the cell.
3. Fix the position of the upright carring the photovoltaic cell near one end on the optical bench (if it is not fix). Switch on the lamp and bring the upright carrying the lamp housing close to the cell so that galvanometer deflection becomes maximum and is within the scale. Note the galvanometer reading and the position of the uprights.
4. Displace the upright carrying the lamp housing away from the cell by few centimeters and note its position. Also not the corresponding value of the galvanometer deflection.
5. Repeat step 4 to obtain a set of at least six observations.
6. Find the distance " r " between the lamp and the cell for each observation. Calculate r^2 and $1/r^2$
7. Plot a graph between galvanometer deflection Θ and $1/r^2$.

OBSERVATION:-

Sr. No.	Position of upright carrying		Galvanometer deflection Θ	Distance r = y – x (cm.)	r^2 (cm^2)	$1/r^2$ (cm^{-2})
	Photovoltaic cell X (cm)	Lamp housing Y (cm)				
1.						
2.						
3.						
4.						
5.						
6.						

Result:-

The graph between galvanometer deflection Θ and $1/r^2$ is a straight line as a shown in fig. therefore, inverse square law of light is verified.