ILAHIA COLLEGE OF ENGINEERING AND TECHNOLOGY

ENGINEERING PHYSICS LAB MANUAL

PHL120

(For First Year B.Tech As Per Kerala Technological University Syllabus)

INDEX

EXPT. NO

AIR WEDGE

DATE:

AIM: To determine the thickness of a thin strip by air wedge method.

APPARATUS: Air wedge, travelling microscope, sodium light, reading lens.

PRINCIPLE: Thickness of the paper strip is $t = \frac{\lambda L}{2\beta}$ where

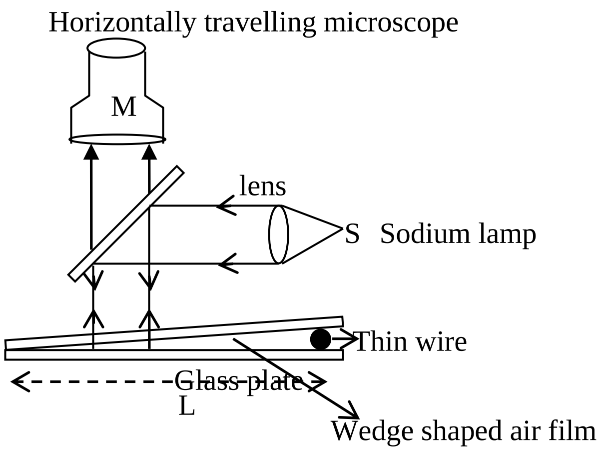
t is the thickness of the wire,

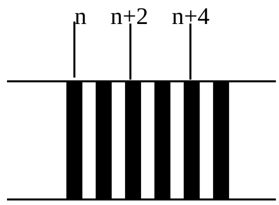
λ is the wavelength of the light,

β is the fringe width

PROCEDURE:

1. The wire is kept between two optically plane glass plates and the plates are tied together to form an air wedge.
2. Light from sodium vapour lamp is rendered parallel by a convex lens and is made to reflect from a glass plate, which is kept at 45^0, so that it is incident normally on the air wedge.
3. Equidistant parallel dark and bright interference bands are formed.
4. This band system is viewed throught he eye piece of the horizontal travelling microscope.
5. Reading is taken corresponding to the centre of any dark band (n^{th} band) and readings are repeated for dark bands corresponding to n+2, n+4, n+6 etc.
6. The fringe width β is calculated.
7. Measure the length of the air wedge L.
8. Substituting the wavelength of sodium light used, the thickness of the strip is calculated using the formula $t = \frac{\lambda L}{2\beta}$.





OBSERVATIONS:

(a) To find least count

Value of 1msd = 0.05 cm

Total number of vernier divisions, N = 50 cm

Least count = 1msd/N = 0.001 cm

Total reading = MSR + (VSR $\times$ LC) cm where

MSR – main scale reading (cm); VSR – vernier scale reading (cm); LC – least count (cm)

b) To find fringe width

Order of dark fringe	Microscopic Readings			Width of 10 bands 10β cm	Mean width 10β cm	Fringe width βcm
	MSR	VSR	Total reading			
n						
$n+2$						
$n+4$						
$n+6$						
$n+8$						
$n+10$				$(n+10) - (n)$		
$n+12$				$(n+12) - (n+2)$		
$n+14$				$(n+14) - (n+4)$		
$n+16$				$(n+16) - (n+6)$		
$n+18$				$(n+18) - (n+8)$		

Mean fringe width, β = ... cm

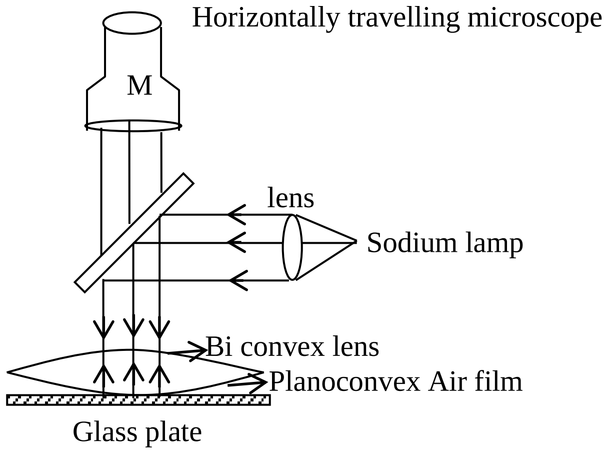
Length of the wedge, L = ...$4.2\text{x}10^{-2}$m

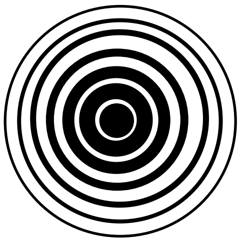
Wavelength of sodium light, λ = $5893\text{x}10^{-8}$cm

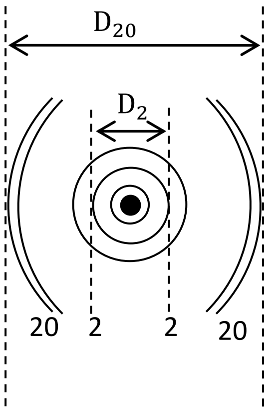
Thickness of paper strip t = $\frac{\lambda L}{2\beta}$ = ... cm

RESULT:

Thickness of the paper strip = ... cm







OBSERVATIONS:

(a) To find least count

Value of 1msd = 0.05 cm

Total number of vernier divisions, N = 50 cm

Least count = 1msd/N = 0.001 cm

Total reading = MSR + (VSR × LC) cm where

MSR - main scale reading (cm)

VSR – vernier scale reading (cm)

LC – least count (cm)

NEWTONS RINGS (WAVELENGTH DETERMINATION)

AIM: To determine the wavelength of sodium light using the reflected light.

APPARATUS: Newton's rings apparatus, travelling microscope, sodium light, planoconvex lens or biconvex lens of large focal length.

PRINCIPLE: Wavelength of the sodium light $\lambda = \frac{(D_m{}^2 - D_n{}^2)}{4(m-n)R}$

where D_m is the diameter of m^{th} dark ring;

D_n is the diameter of n^{th} dark ring;

λ is the wavelength of the light,

R is radius of curvature of the lower surface of biconvex lens or planoconvex lens.

PROCEDURE: A convex lens L_1 of short focal length is kept at a suitable distance from a sodium vapour lamp so that parallel rays are falling on an inclined glass plate. These rays are reflected down by the glass plate and are allowed to fall normally on a bi convex lens or a plano convex lens L placed on an optically plane glass plate P. A set of dark and bright concentric circular rings is formed.

A microscope is mounted with its axis vertical. Its eye piece is adjusted till its cross wires are seen most clearly. It is then arranged above the Newton's rings apparatus and is raised or lowered until the rings are observed very clearly. The apparatus or the lens can e slightly adjusted in order to get the clear rings.

From the centre of the ring system, the microscope is moved towards the left and the cross wire is made to coincide tangentially on the 20^{th} dark ring. The reading of the horizontal scale is taken. By rotating the horizontal screw, the cross wire is carefully moved towards the right. It is then made tangential to 18^{th}, 16^{th}, 12^{th}, 10^{th}, 8^{th}, 6^{th}, 4^{th} etc in succession upto the 2^{nd} ring and the readings are taken in each position. Then it is moved to the right side of the centre and placed tangential to 2^{nd}, 4^{th}, 6^{th}, 8^{th} upto the 20^{th} dark ring and readings are taken. Difference between the readings on left and right of each ring gives the diameter D of that ring.

The square of the diameter D^2 is calculated. The difference in value of D^2 is calculated. The difference in value of D^2 of 10 rings apart is calculated. This is nearly constant and average value of $(D_m^2 - D_n^2)$ is calculated by keeping the value of (m-n) equal to 10.

(b) To determine $(D_m^2 - D_n^2)$

Order of dark ring	Microscopic Readings						D (cm)	D^2 (cm^2)	$(D_m^2 - D_n^2)$ (cm^2)
	LHS			RHS					
	MSR	VSR	Total Reading (cm)	MSR	VSR	Total Reading (cm)			
20							D_{20} =	D_{20}^2=	
18							D_{18} =	D_{18}^2=	
16							D_{16} =	D_{16}^2=	
14							D_{14} =	D_{14}^2=	
12							D_{12} =	D_{12}^2=	
10							D_{10} =	D_{10}^2=	
8							D_8 =	D_8^2=	
6							D_6 =	D_6^2=	
4							D_4 =	D_4^2=	
2							D_2 =	D_2^2=	

Mean $(D_m^2 - D_n^2)$ = ... cm^2

Radius of curvature of lens (R) = ...130..... cm ; $\lambda = \frac{(D_m^2 - D_n^2)}{4(m-n)R}$ =

By substituting the known value of the radius of curvature of the lens, the wavelength of the monochromatic source is calculated using the formula, $\lambda = \frac{(D_m{}^2 - D_n{}^2)}{4(m-n)R}$

RESULT:

Wavelength of sodium light = ...

OBSERVATION:

To find linear density of the string (m)

Length of the string = ...1.7...................... m

Mass of the string = ..0.658.............................gm

Linear density, m = ...0.387×10^{-3}.................... kg/m

Acceleration due to gravity, g = $9.8 m/s^2$

(a) Transverse mode of vibration:

Mass of scale pan = ...16.8g =.............kg

No	Mass in the scale pan Kg	Total mass including the mass of pan M kg	Number of loops X	Length of X loops L(m)	Length of one loop $l = \left(\frac{L}{X}\right)$ m	$\left(\frac{M}{l^2}\right) {Kg}/{m^2}$
	1×10^{-3}	17.8×10^{-3}	3	0.303		
	2×10^{-3}	18.8×10^{-3}	4	0.4112		
	3×10^{-3}	19.8×10^{-3}	4	0.43		

Mean $\left(\frac{M}{l^2}\right)$ **= ....**

Frequency of the tuning fork , n = $\left[\frac{g}{4m}\left(\frac{M}{l^2}\right)\right]^{\frac{1}{2}}$ = ...

MELDE'S STRING

AIM: To determine the frequency of a tuning fork by Melde's arrangement,

(a) using transverse mode of vibration

(b) using longitudinal mode of vibration

APPARATUS: Electrically maintained tuning fork, line thread, scale pan, weight box, common balance etc. The Melde's arrangement consists of an electrically maintained tuning fork. One end of a fine string is attached to one of the prongs of the fork. The other end of the string is passed over a pulley carrying a scale pan.

PRINCIPLE:

(a) Transverse mode of vibration:

The frequency of tuning fork is calculated using the formula

$$\mathbf{n} = \left[\frac{\mathbf{g}}{\mathbf{4m}}\left(\frac{\mathbf{M}}{l^2}\right)\right]^{\frac{1}{2}}$$

(b) Longitudenal mode of vibration:

The frequency of tuning fork is calculated using the formula

$$\mathbf{n} = \left[\frac{\mathbf{g}}{\mathbf{m}}\left(\frac{\mathbf{M}}{l^2}\right)\right]^{\frac{1}{2}}$$

where g is the acceleration due to gravity (m/s^2); m is the linear density of the string (mass per unit length) (kg/m); total mass attached at the end of the string (kg); average length of one loop for a mass M (*l*) .

PROCEDURE:

(a) Transverse mode of vibration:

The electrical connections are made as shown in the diagram. The string is arranged horizontally with its length parallel to the prong of the tuning fork. Here the fork vibrates in a direction perpendicular to the length of the string. A mass of 2 or 3 grams is placed in the scale pan. The circuit is closed. The fork vibrates. Transverse stationary waves are formed in the string. The length of the string between the prong and the pulley is carefully adjusted by moving the fork, so that a number of well defined loops are formed in the string. Leaving the loops at the two ends, the lengths of a definite number of loops are measure. Then the average length of a loop is found. The total mass

(b) Longitudinal mode of vibration:

Mass of scale pan = ...kg

No	Mass in the scale pan Kg	Total mass including the mass of pan M kg	Number of loops X	Length of X loops L(m)	Length of one loop l = $\left(\frac{L}{X}\right)$ m	$\left(\frac{M}{l^2}\right) {Kg}/{m^2}$

Mean $\left(\frac{M}{l^2}\right)$ = **.........................**

Frequency of the tuning fork , n = $\left[\frac{g}{m}\left(\frac{M}{l^2}\right)\right]^{\frac{1}{2}}$ = ...

M at the end of the string (mass of the scale pan + mass placed in the pan) is noted. The value of $\frac{M}{l^2}$ is found. The experiment is repeated for different masses m in the scale pan and the mean value of $\frac{M}{l^2}$ is calculated.

The mass of the scale pan is determined correct to a milligram. 10m of the string is weighed accurately. Hence the linear density (mass per unit length) m is calculated. Then the frequency of the tuning fork is calculated using the formula.

$$n = \left[\frac{g}{4m}\left(\frac{M}{l^2}\right)\right]^{\frac{1}{2}} \quad \text{(Hertz)}$$

(b) Longitudinal mode of vibration:

The apparatus is arranged as shown in the diagram, with the prongs perpendicular to the string. Then the fork vibrates in a direction parallel to the string. The experiment is performed exactly as before for different masses and the mean value $\frac{M}{l^2}$ is found. Then the frequency of the tuning fork is calculated using the formula

$$n = \left[\frac{g}{m}\left(\frac{M}{l^2}\right)\right]^{\frac{1}{2}} \quad \text{(Hertz)}$$

RESULT:

Mean frequency of the tuning fork = ... Hz

OBSERVATION:

Distance of marking between the rulers, d = ...mm

Distance between screen and the laser beam, D = ... m

Order	Distance	$y_m^2 - y_0^2$	$\frac{y_m^2 - y_0^2}{m}$	$\lambda = \frac{d}{2D^2}\left[\frac{y_m^2 - y_0^2}{m}\right]$
0	Y_0 =			
1	Y_1 =			
2	Y_2 =			

LASER DIFFRACTION USING A RULER

AIM: To find the wavelength of the given light source using reflection grating.

PRINCIPLE: Diffraction refers to various phenomena associated with wave propagation, such as bending spreading and interference of waves passing by an object or an aperture that interrupts the wave propagation. A diffraction grating is an optical device with a surface covered by a regular pattern of parallel lines, typically with a distance between the lines comparable to the wavelength of the light.

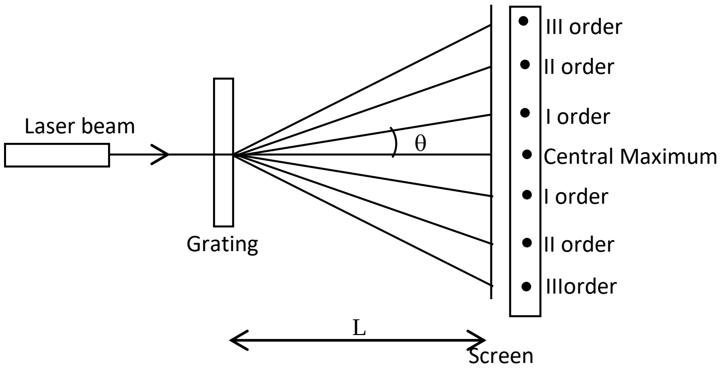
Wavelength of the light used is given by $\lambda = \frac{d}{2D^2}\left[\frac{{y_m}^2 - {y_0}^2}{m}\right]$ where ‘d’ is the distance of marking between the rulers; ‘D’ is the distance between screen and the laser beam on the scale; y_m and y_0 represents the order of the diffraction.

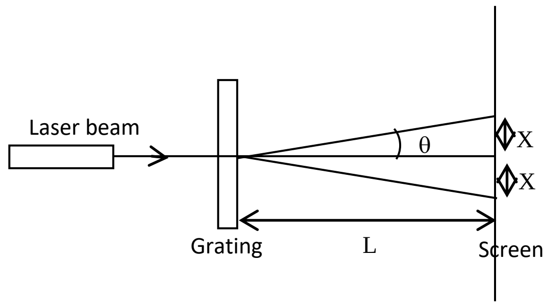
PROCEDURE: Diode laser is mounted on its saddle. A ruler is taken as grating is mounted on a stand. Then the distance between grating and screen is adjusted to get the diffraction pattern. Then the spots are marked on a graph paper. Then the grating is removed and marks the direct ray spot on the graph paper. Then y_0 is calculated as distance between zeroth order and direct ray y_1 as distance between first order and direct ray and so on. Then wavelength is calculated using the formula

$$\lambda = \frac{d}{2D^2}\left[\frac{{y_m}^2 - {y_0}^2}{m}\right]$$

RESULT:

Wavelength of the given source of light =





OBSERVATION

Number of lines per cm on the grating = N = ...5906.................. lines /cm

To determine wavelength of laser source

Distance between screen and grating (L)cm	**Order (*n*)**	**Distance between centre & left spots (cm)**	**Distance between centre & right spots (cm)**	**Mean distance X (cm)**	**Tan θ** $= \frac{X}{L}$	**θ (degree)**	$\lambda = \frac{\sin\theta}{nN}$
15	**1**						
	2						
20	**1**						
	2						
25	**1**						
	2						

Mean λ = ... $\times 10^{-8}$cm.

WAVELENGTH OF LASER – USING PLANE TRANSMISSION GRATING

AIM: To determine the wavelength of laser beam using a plane transmission grating.

APPARATUS: Diode laser, plane diffraction grating, vertical stands, screen etc.

PRINCIPLE: The grating equation is given by

$$\sin\theta = n\mathrm{N}\lambda$$

where λ is the wavelength of laser beam (in metre);

θ is the angle of diffraction (in degrees);

N is the number of lines per unit length (lines/metre);

n is the order of spectrum

PROCEDURE: A semiconductor diode laser (0.5mW) is mounted horizontally so that it produces a horizontal laser beam. The given plane transmission grating is held vertically on a stand at a distance 20cm from the laser. A screen is placed at a distance of 15cm from the grating. When the power is switched on, the beam is incident normally on the grating. The laser beam is diffracted at different angles and hence we get bright spots on the screen. On either side of the central spot, we get I, II, and III order spots. The positions of these spots are marked on the screen. The distance of the spots X on the left hand side and right hand side of the central spot are measured. Mean X is calculated. $\tan\theta = \frac{X}{L}$. From this θ is also calculated. Hence the wavelength of laser beam, λ is calculated using the formula $\boldsymbol{\lambda = \frac{\sin\theta}{n\mathrm{N}}}$. The experiment is repeated by keeping the distance between grating and screen L = 20cm, 25cm etc.

RESULT:

Wavelength of laser beam = ... $\times 10^{-8}$cm.

OBSERVATIONS:

Frequency measurements

1	Number of division covered by one cycle (x) = ...1.......... div
2	Time per division factor (y) = ..0.1msec................
3	Time for one cycle (T) = (x).(y) = ...0.1.....m sec
4	Frequency = $\frac{1}{T}$ = ...10........... kHz

Amplitude measurements

1	Peak to peak distance covered by wave form (p) = ...1..... div
2	Volt per division factor (z) = ...1.......... volt
3	Peak to peak voltage (A) = (p).(z) = ...1......... volt
4	Amplitude of oscillations = $\frac{A}{2}$ = ...0.5....... volt

CATHODE RAY OSCILLOSCOPE

AIM: To measure frequency and amplitude of a signal using CRO.

APPARATUS: Cathode Ray Oscilloscope, Function generator, a pair of BNC connectors.

PRINCIPLE: Cathode Ray Oscilloscope is a graph displaying device that traces graph of a measured electrical signal on its screen. The graph shows how signals change over time. The vertical axis of the screen represents voltage and the horizontal axis represents time. With a CRO, the amplitude, period, and frequency of a signal can be measured. Also determinations of pulse width, duty cycle, rise time and fall time of a pulse wave form are possible. Oscilloscopes can display two signals on the screen at a time, so that we can observe their time relationship.

PROCEDURE: Switch on the oscillator. Place the time base knob in horizontal input position and wait for a couple of minutes. Notice a bright spot of light on the screen of the CRO. Move the spot in vertical or horizontal direction by using the horizontal position knob and vertical position knob respectively. Place the time base in appropriate position. Notice a bright line on the CRO screen. CRO is now ready to measure voltage and frequency of the unknown signal.

To measure frequency of a signal:

Switch on the CRO. Obtain a sharply defined trace of horizontal line on the screen by adjusting INTENSITY and FOCUS knobs. Feed the signal whose frequency is to be measured, to either of the channels using a probe and observe the signal on CRO. Adjust the TIME/DIV knob so as to see two or three cycles of the wave form. Count the number of division in one cycle of waveform. Multiply this by the time base setting. Note down the magnification factor from MAGN switch. Divide the value obtained by the magnification factor. This is the time period of a signal. Reciprocal of the time period will give the frequency of the signal.

To measure amplitude of a signal:

Switch ON the CRO. Obtain a sharply defined trace of a horizontal line on the screen by adjusting INTENS and FOCUS knobs. Adjust the Y – position knob to make the trace to coincide with the centre line on the screen by keeping the AC-DC switch in GND position. Connect the voltage to be measured to either of the channel using a probe and observe the signal on CRO. Count the number of divisions occupied by the signal from peak to peak. Multiply this by the scale indicated by the

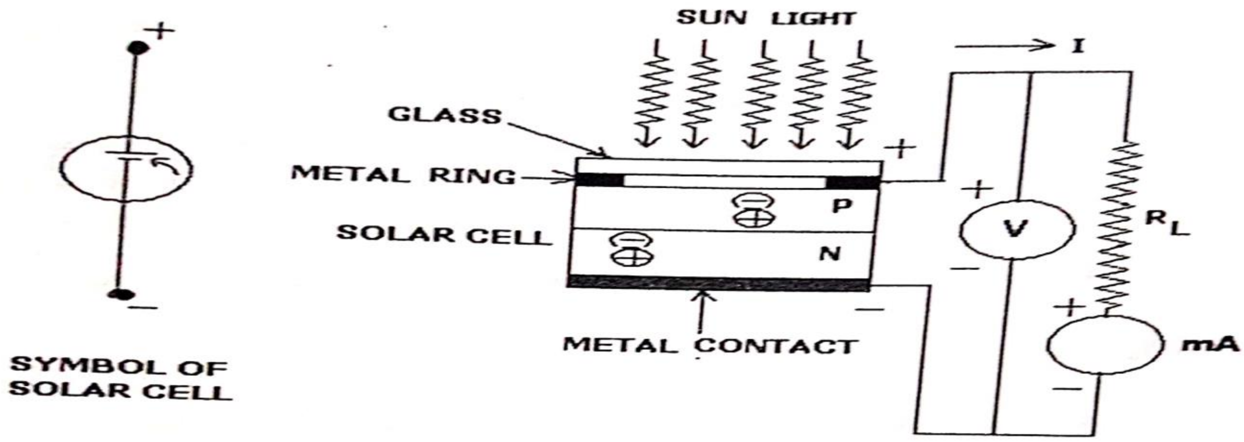
AMP/DIV knob. This gives the peak to peak amplitude of the signal. Half of this will give the maximum peak value of the voltage.

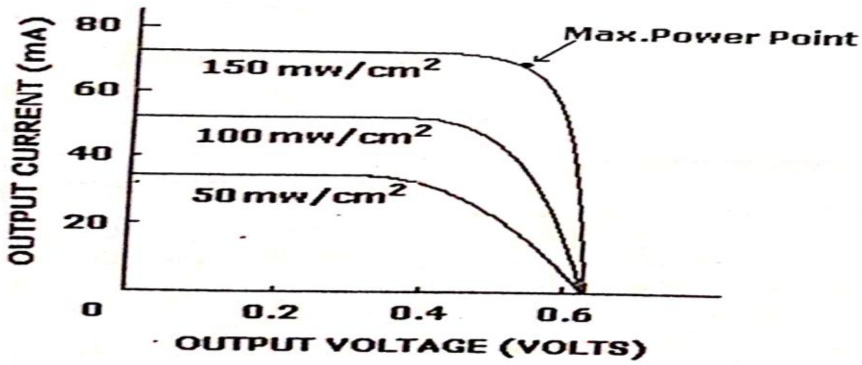
RESULT:

The frequency and amplitude of a signal are measured using Cathode Ray Oscilloscope and is as given.

(i) Frequency of the signal = ...

(ii) Amplitude of the signal = ...





I - V CURVE OF A SOLAR CELL

OBSERVATIONS

To plot Current – Voltage characteristics

SL No	R_L Ω	Intensity I_1		Intensity I_2	
		Voltage V	Current mA	Voltage V	Current mA
1	V_{OC}				
2	I_{SC}				
3	100				
4	200				
5	300				
6	400				
7	500				
8	600				
9	700				
10	800				
11	900				
12	1000				

I – V CHARACTERISTICS OF A SOLAR CELL

AIM: To determine current – voltage characteristics of a solar cell.

APPARATUS: Solar panel, voltmeter, milliammeter, resistance box, 100 watts lamp, area choppers etc.

PRINCIPLE: A graph showing the variation of voltage and current of a solar cell is called as current – voltage characteristics. In an open circuit, a solar cell has an output voltage of 0.6V and zero current while in a short circuit, the current value becomes maximum and output voltage becomes zero.

PROCEDURE:

1. At first, adjust the lamp intensity to minimum.
2. Measure the voltage in open circuit with zero load resistance.
3. Now introduce 100Ω load resistance, measure current and voltage values.
4. Increase the load resistance in steps of 100Ω and measure current and voltage values in each case.
5. The above procedure is repeated for different intensity.
6. Now plot a graph connecting voltage and current.
7. This I-V curve is called as output characteristic curve.

RESULT:

Current – Voltage characteristic curve of solar cell is plotted.

OBSERVATIONS:

<table>
<tr><td rowspan="4">Tan A</td><td>r
(m)</td><td>θ_1</td><td>θ_2</td><td>θ_3</td><td>θ_4</td><td>θ_5</td><td>θ_6</td><td>θ_7</td><td>θ_8</td><td>mean
θ degree</td><td>m
(Am^2)</td></tr>
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DEFLECTION MAGNETOMETER – To find the moment of a bar magnet

AIM: To find the moment of a bar magnet in tan A position using deflection magnetometer.

APPARATUS: Deflection magnetometer and a bar magnet.

PRINCIPLE: From tangent law, $B = B_H \tan\theta$; we know that $B = \frac{\mu_0}{4\pi} \times \frac{2m}{r^3}$.

Therefore $\frac{\mu_0}{4\pi} \times \frac{2m}{r^3} = B_H \tan\theta$

$$\boldsymbol{m = \frac{2\pi r^3 B_H \tan\theta}{\mu_0}}$$

where 'r' is the distance from the centre of the compass box; B_H is the horizontal intensity of earth's magnetic field; 'θ' is the deflection of aluminium pointer; μ_0 is the magnetic permeability of free space.

Taking $B_H = 0.58\times10^{-4}$ T and $\mu_0 = 4\pi \times 10^{-7}$ H/m, we can find the value of magnetic moment of the bar magnet.

PROCEDURE: The deflection magnetometer is arranged in tan A position. For that, the compass box alone is rotated so that the (0-0) line is parallel to the arm of the magnetometer. Then the apparatus as a whole is rotated till the aluminium pointer reads (0-0). The bar magnet is placed horizontally parallel to the arm of the deflection magnetometer at a distance 'r' from the center of the compass needle. The reading of the ends of the pointer is noted. The magnet is then reversed at the same position and the readings of the pointer are again noted. The magnet is then transferred to the other arm of the deflection magnetometer. Keeping the same distance 'r' four more deflections are noted. The average of 8 deflections is noted. Experiment is repeated fro different values of 'r'.

RESULT: Magnetic moment of the given bar magnet = ………………… Am^2