



PUNNA International School

Shree Swaminarayan Gurukul, Zundal

Term – II

Class – XII

Subject: Physics

Experiment (2021_22)

Exp. No	Aim
5	To find the focal length of a convex lens by plotting graphs between u and v or between $1/u$ and $1/v$.
6	To find the focal length of a convex mirror, using a convex lens.
7	To determine angle of minimum deviation for a given prism by plotting a graph between angle of incidence and angle of deviation
8	To draw the I-V characteristic curve for a p-n junction diode in forward bias and reverse bias.
	Activities
4	To identify a diode, an LED, a resistor and a capacitor from a mixed collection of such items.
5	To observe polarization of light using two Polaroids
6	To observe diffraction of light due to a thin slit

Experiment – 5

Aim

To find, the focal length of a convex lens by plotting graphs between u and v or between $1/u$ and $1/v$.

Apparatus

An optical bench with three uprights (central upright fixed, two outer uprights with lateral movement), a convex lens with lens holder, two optical needles, (one thin, one thick) a knitting needle and a half metre scale.

Theory

The relation between u , v and f for a convex lens is

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u} \Rightarrow \frac{1}{f} = \frac{u-v}{uv} \Rightarrow f = \frac{uv}{u-v}$$

where,

f = focal length of convex lens

u = distance of object needle from optical centre of the lens

v = distance of image needle from optical centre of the lens.

Ray diagram

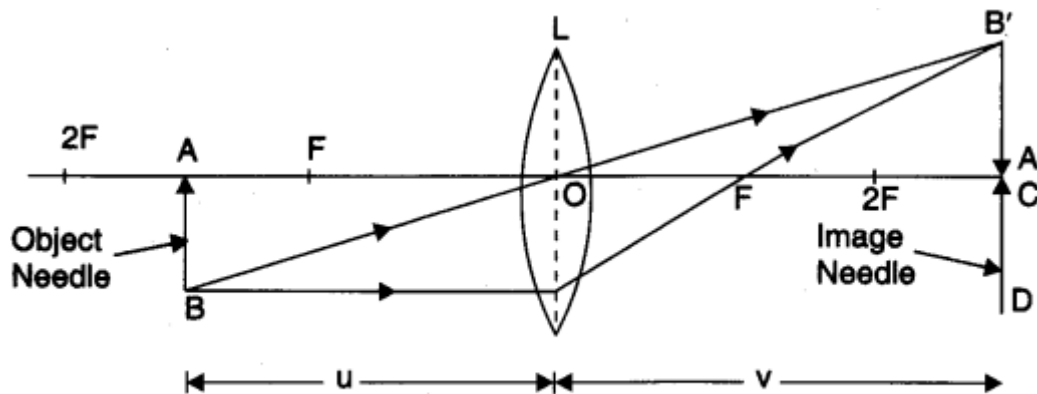


Fig. Focal length of convex lens.

Procedure

To determine rough focal length

1. Mount the concave mirror in mirror holder.
2. Go out in the open and face the mirror towards distant tree or building.
3. Obtain the image of the tree or the building on a white painted wall (screen) and move the mirror forward and backward to get a sharp image on the wall.
4. Measure the distance between the mirror and the wall (screen). This will be equal to the rough focal length of the mirror.

To set the lens

5. Clamp the holder with lens in a fixed upright and keep the upright at 50 cm mark.

- Adjust the lens such that its surface is vertical and perpendicular to the length of the optical bench.
- Keep the upright fixed in this position throughout.

To set the object needle

- Take the thin optical needle as object needle (O). Mount it in outer laterally moveable upright near zero end.
- Move the object needle upright and clamp it at a distance (in full cms) nearly 1.5 times the obtained rough focal length of the lens.
- Adjust height of the object needle to make its tip lie on horizontal line through the optical centre of the lens.
- Note the position of the index mark on the base of the object needle upright.

To set the image needle

- With left eye closed, see with the right open eye from the other end of the optical bench. An inverted and enlarged image of the object needle will be seen. Tip of the image must lie in the middle of the lens.
- Mount the thick optical needle (image needle) in the fourth upright near the other end of the optical bench.
- Adjust the height of the image needle so that its tip is seen in line with the tip of the image when seen with right open eye.
- Move the eye towards right. The tips will get separated. The image tip and the image needle tip have parallax.
- Remove the parallax tip to tip.
- Note the position of the index mark on base of the image needle upright.
- Record the position of the index marks on the base of upright of the lens, the object needle and the image needle in the table against observation 2.

To determine index correction

- Find the index correction for distance between optical centre of lens and tip of the object needle and also for distance between optical centre of lens and tip of the image needle as described.

To get more observations

- Move object needle upright towards mirror in steps of 1 cm to get observation 2 and 1. Repeat the experiment.

Observations

Rough focal length of the given convex lens =cm

Actual length of the knitting needle $x =$ cm

Observed distance between the object needle and the lens when knitting needle is placed between them $y =$ cm

Observed distance between the image needle and the lens when knitting needle is placed between them $z =$ cm

Index correction for the object distance u , $x - y =$ cm

Index correction for the image distance v , $x-z = \dots\dots$ cm

Table for u , v ; $\frac{1}{u}$ and $\frac{1}{v}$

Serial No. of Obs.	Position of			Observed distance		Corrected distance		$\frac{1}{u}$ (cm^{-1}) (5)	$\frac{1}{v}$ (cm^{-1}) (6)
	Object needle A (cm) (2a)	Lens O (cm) (2b)	Image needle C (cm) (2c)	OA = u (cm) (3a)	OC = v (cm) (3b)	u (cm) (4a)	v (cm) (4b)		
	(1)	(2a)	(2c)	(3a)	(3b)	(4a)	(4b)		
1.									
2.									
3.									
4.									
5.									
6.									

Calculations

Calculations of focal length by graphical methods:

(i) u - v Graph. Select a suitable but the same scale to represent u along X' -axis and v along Y -axis. According to sign conventions, in this case, u is negative and v is positive. Plot the various points for different sets of values of u and v from observation table second quadrant. The graph comes out to be a rectangular hyperbola as shown in graph between u and v .

Draw a line OA making an angle of 45° with either axis (i.e., bisecting $\angle YOX'$) and meeting the curve at point A . Draw AB and AC perpendicular on X' - and Y -axes, respectively.

be $(2f, 2f)$, because for a convex lens, when $u = 2f$, $v = 2f$.

Hence, $AB = AC = 2f$ or $OC = OB = 2f$

$$\therefore f = \frac{OB}{2} \quad \text{and also } f = \frac{OC}{2}$$

\therefore Mean value of $f = \dots\dots$ cm

Result

The focal length of the given convex lens as determined from

1. focal length from $f = \frac{vu}{u-v}$

2. $(u-v)$ graph = $\dots\dots$ cm

3. $\left(\frac{1}{u} - \frac{1}{v}\right)$ graph = $\dots\dots$ cm

and 4. $(u-v)$ graph = $\dots\dots$ cm.

Precautions

1. Tips of the object and image needles should lie at the same height as the centre of the lens.
2. Parallax should be removed from tip to tip by keeping eye at a distance at least 30 cm away from the needle.
3. The object needle should be placed at such a distance that only real, inverted image of it is formed.
4. Index correction for u and v should be applied.

Sources of error

1. The uprights may not be the vertical.
2. Parallax removal may not be perfect.

Experiment – 6

Aim

To find the focal length of a convex mirror, using a convex lens.

Apparatus

An optical bench with four uprights (two fixed uprights in middle, two outer uprights with lateral movement), convex lens (20 cm focal length), convex mirror, a lens holder, a mirror holder, two optical needles, (one thin, one thick) a knitting needle, and a half metre scale.

Theory

$$\text{Focal length of a convex mirror } f = \frac{R}{2}$$

where R = radius of curvature of the mirror.

Ray Diagram

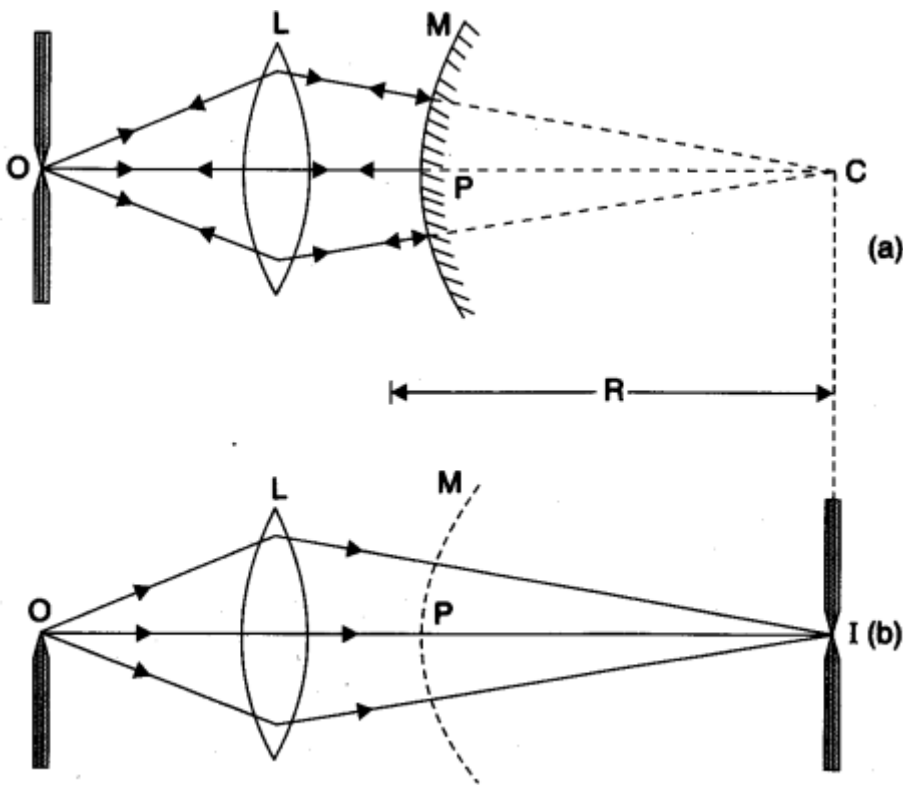


Fig. Focal length of convex mirror.

Procedure

To determine rough focal length of convex lens

1. To set the lens
2. Clamp the holder with lens in a fixed upright and keep the upright at 50 cm mark.

3. Adjust the lens such that its surface is vertical and perpendicular to the length of the optical bench.
4. Keep the upright fixed in this position throughout.

To set the object needle

5. Take the thin optical needle as object needle (O). Mount it in outer laterally move-able upright near zero end.
6. Move the object needle upright and clamp it at a distance (in full cm) nearly 1.5 times the obtained rough focal length of the lens.
7. Adjust height of the object needle to make its tip lie on horizontal line through the optical centre of the lens.
8. Note the position of the index mark on the base of the object needle upright.

To set the convex mirror

9. Clamp the holder with convex mirror in second fixed upright near the lens upright, keeping reflecting surface of the mirror towards lens.
10. Adjust the height of the mirror to make its pole lie on horizontal line through the optical centre of the lens.
11. Make the mirror surface vertical and perpendicular to the length of the optical bench (the principal axes of mirror and lens must coincide.)
12. Move towards zero end of the optical bench (where object needle is mounted).
13. Closing left eye, keep open right eye about 30 cm away from the tip of the object needle.
14. See the inverted image of the object needle (formed by reflection from the convex mirror).
15. Keep the eye in a position at which the tips of the inverted image and the object needle are seen simultaneously.
16. Adjust the height of the needle so that the two tips are seen in one line with right open eye.
17. Move the eye towards right. The tips will get separated. The tips have parallax.
18. Move the convex mirror back and forth till tip to tip parallax is removed.
19. Note the position of the index mark on the base of the convex mirror upright.

To set the image needle

20. Remove the convex mirror, keeping upright in its position.
21. With left eye closed, see with the right open eye from the other end of the optical bench. An inverted and enlarged image of the object needle will be seen. Tip of the image must lie in the middle of the lens.
22. Mount the thick optical needle (image needle) in the fourth upright near the other end of the optical bench.
23. Adjust the height of the image needle so that its tip is seen in line with the tip of the image when seen with right open eye.
24. Move the eye towards right. The tips will get separated. The image tip and the image needle tip have parallax.
25. Remove the parallax tip to tip.

26. Note the position of the index mark on base of the image needle upright.
27. Record the position of the index marks in the table against observation 2.

To determine index correction

28. Find index correction for distance between pole of convex mirror and tip of the image needle as described.

Observations

Rough focal length of the convex lens =

Actual length of the knitting needle, x =

Observed distance between image needle I and back of the convex mirror

y =

∴ Index correction = $(x - y)$,

=

Result

The focal length of the given convex mirror =cm.

Precautions

1. Principal axis of the lens should be horizontal and parallel to the central line of the optical bench.
2. All the uprights should be vertical.
3. The tip of the needle, centre of the mirror and centre of the lens should be at the same height.
4. While removing the parallax, the eye should be kept at a minimum distance of 30 cm from the needle.
5. Tip to tip parallax should be removed.
6. Index correction should be applied between the image needle I and back surface of the convex mirror.
7. The convex mirror should be placed close to the convex lens.
8. For one set of observation, when the parallax has been removed for convex lens alone, the positions of the lens and needle O uprights should not be changed.

Sources of error

1. Focal length of lens may not be small.

Experiment – 7

Aim

To determine angle of minimum deviation for a given prism by plotting a graph between angle of incidence and the angle of deviation.

Apparatus

Drawing board, a white sheet of paper, prism, drawing pins, pencil, half-metre scale, office pins, graph paper and a protractor.

Theory

The refractive index (n) of the material of the prism is given by

$$n = \frac{\sin\left(\frac{A + D_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

where, D_m angle of minimum deviation and A angle of the prism.

Diagram

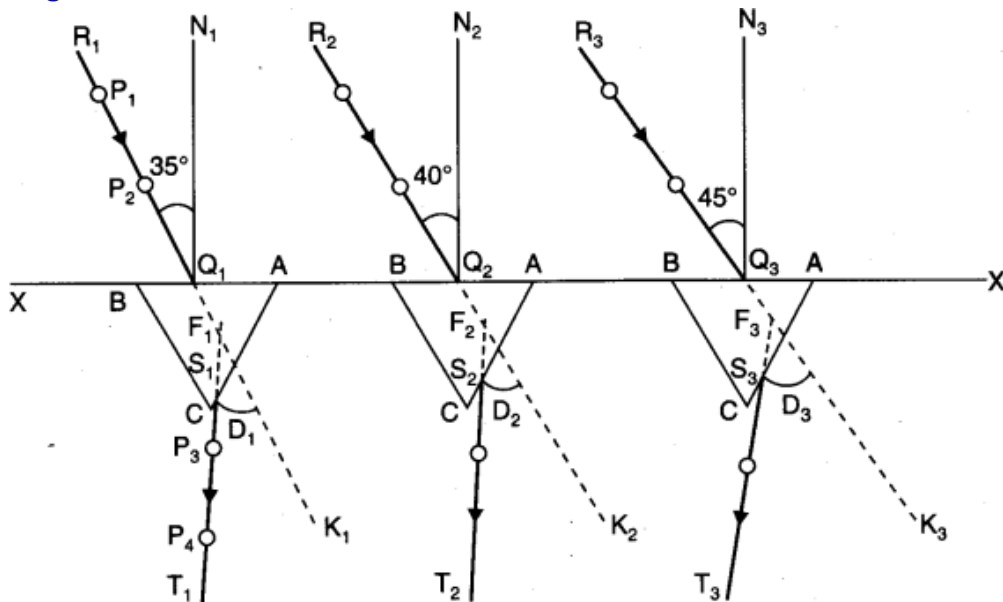


Fig. Refraction through prism at different angles.

Procedure

1. Fix a white sheet of paper on the drawing board with the help of drawing pins or tape.
2. Draw a straight line XX' parallel to the length of the paper nearly in the middle of the paper.
3. Mark points Q_1, Q_2, Q_3, \dots on the straight line XX' at suitable distances of about 5 cm.
4. Draw normals $N_1Q_1, N_2Q_2, N_3Q_3, \dots$ on points Q_1, Q_2, Q_3, \dots as shown in diagram.
5. Draw straight lines $R_1Q_1, R_2Q_2, R_3Q_3, \dots$ making angles of $35^\circ, 40^\circ, \dots 60^\circ$ (write value of the angles on the paper) respectively with the normals.
6. Mark one corner of the prism as A and take it as the edge of the prism for all the observations.
7. Put it prism with its refracting face AB in the line XX' and point Q_1 in the middle of AB .

8. Mark the boundary of the prism.
9. Fix two or more office pin P_1 and P_2 vertically on the line R_1Q_1 . The distance between the pins should be 10 mm or more.
10. Look the images of point P_1 and P_2 through face AC.
11. Close your left eye and bring open right eye in line with the two images.
12. Fix two office pins P_3 and P_4 vertically, and 10 cm apart such that the open right eye sees pins P_4 and P_3 and images of P_2 and P_1 in one straight line.
13. Remove pins P_3 and P_4 and encircle their pricks on the paper.
14. Repeat steps 7 to 13 with points Q_2, Q_3, \dots for $i = 40^\circ, \dots, 60^\circ$.

To measure D in different cases

15. Draw straight lines through points P_4 and P_3 (pin pricks) to obtain emergent rays $S_1T_1, S_2T_2, S_3T_3, \dots$
16. Produce $T_1S_1, T_2S_2, T_3S_3, \dots$ inward in the boundary of the prism to meet produced incident rays $R_1Q_1, R_2Q_2, R_3Q_3, \dots$ at points F_1, F_2, F_3, \dots
17. Measure angles $K_1F_1S_1, K_2F_2S_2, K_3F_3S_3, \dots$. These give angle of deviation D_1, D_2, D_3, \dots
18. Write values of these angles on the paper.

To measure A

19. Measure angle BAC in the boundary of the prism. This gives angle A.
20. Record your observations.

Observations

Angle of prism 'A' =

<i>Serial No. of Obs.</i>	<i>Angle of incidence $\angle i$</i>	<i>Angle of deviation $\angle D$</i>
1.	35°	
2.	40°	
3.	45°	
4.	50°	
5.	55°	
6.	60°	

Calculations

Plot a graph between angle of incidence $\angle i$ and angle of deviation $\angle D$ by taking $\angle i$ along X-axis and $\angle D$ along Y-axis. From this graph, find the value of single of minimum deviation D_m corresponding to the lowest point of the graph.

Let the value of angle of minimum deviation, $D_m = \dots$

Then,
$$n = \frac{\sin\left(\frac{A + D_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

Result

1. i - D graph indicates that as the angle of incidence (i) increases, the angle of deviation (D) first decreases, attains a minimum value (D_m) and then starts increasing for further increase in angle of incidence.
2. Angle of minimum deviation, $D_m = \dots\dots\dots$
3. Refractive index of the material of the prism, $n = \dots\dots\dots$

Precautions

1. The angle of incidence should lie between 35° - 60° .
2. The pins should be fixed vertical.
3. The distance between the two pins should not be less than 10 mm
4. Arrow heads should be marked to represent the incident and emergent rays.
5. The same angle of prism should be used for all the observations.

Sources of error

1. Pin pricks may be thick.
2. Measurement of angles may be wrong.

Experiment – 8

Aim

To draw the I-V characteristic curve of a p-n junction in forward bias and reverse bias.

Apparatus

A p-n junction (semi-conductor) diode, a 3 volt battery, a 50 volt battery, a high resistance rheostat, one 0-3 volt voltmeter, one 0-50 volt voltmeter, one 0-100 mA ammeter, one 0-100 μ A ammeter, one way key, connecting wires and pieces of sand paper.

Theory

Forward bias characteristics. When the p -section of the diode is connected to positive terminal of a battery and n-section is connected to negative terminal of the battery then junction is said to be forward biased. With increase in bias voltage, the forward current increases slowly in the beginning and then rapidly. At about 0.7 V for Si diode (0.2 V for Ge), the current increases suddenly. The value of forward bias voltage, at which the forward current increases rapidly, is called cut in voltage or threshold voltage. **Reverse bias characteristics.** When the p -section of the diode is connected to negative terminal of high voltage battery and n-section of the diode is connected to positive terminal of the same battery, then junction is said to be reverse biased.

When reverse bias voltage increases, initially there is a very small reverse current flow, which remains almost constant with bias. But when reverse bias voltage increases to sufficiently high value, the reverse current suddenly increases to a large value. This voltage at which breakdown of junction diode occurs (suddenly large current flow) is called zener breakdown voltage or inverse voltage. The breakdown voltage may start from one volt to several hundred volts, depending upon dopant density and the depletion layer.

Diagram

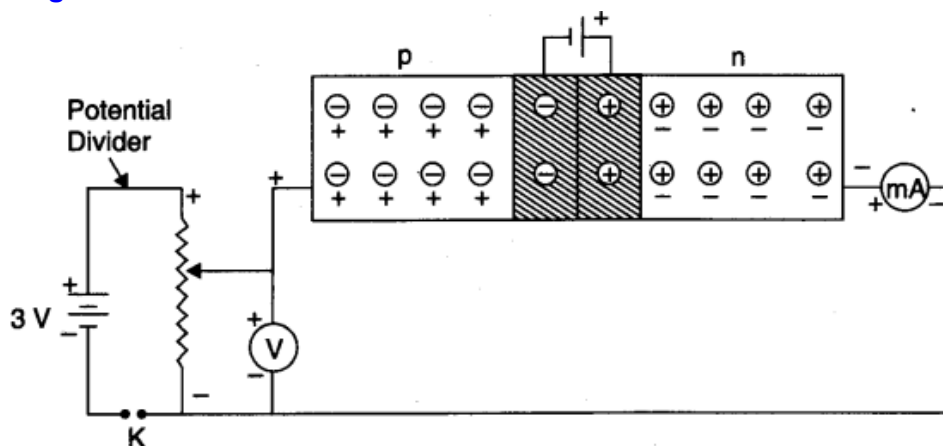


Fig. p-n junction diode—forward biased.

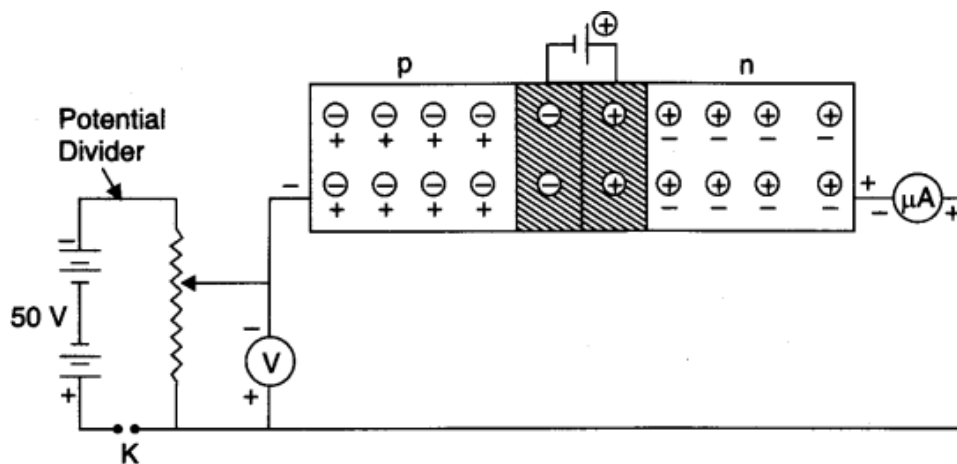


Fig. p-n junction diode—reverse biased.

Procedure

For forward-bias

1. Make circuit diagram as shown in diagram.
2. Make all connections neat, clean and tight.
3. Note least count and zero error of voltmeter (V) and milli-ammeter (mA).
4. Bring moving contact of potential divider (rheostat) near negative end and insert the key K. Voltmeter V and milli-ammeter mA will give zero reading.
5. Move the contact a little towards positive end to apply a forward-bias voltage (V_F) of 0.1 V. Current remains zero.
6. Increase the forward-bias voltage upto 0.3 V for Ge diode. Current remains zero, (It is due to junction potential barrier of 0.3 V).
7. Increase V_F to 0.4 V. Milli-ammeter records a small current.
8. Increase V_F in steps of 0.2 V and note the corresponding current. Current increases first slowly and then rapidly, till V_F becomes 0.7 V.
9. Make $V_F = 0.72$ V. The current increases suddenly. This represents "forward break-down" stage.
10. If the V_F increases beyond "forward breakdown" stage, the forward current does not change much. Now take out the key at once.
11. Record your observations as given ahead.

For reverse-bias

12. Make circuit diagram as shown in diagram.
13. Make all connections neat, clean and tight.
14. Note least count and zero error of voltmeter (V) and micro-ammeter (μ A).
15. Bring moving contact of potential divider (rheostat) near positive end and insert the key K. Voltmeter V and micro-ammeter μ A will give zero reading.
16. Move the contact towards negative end to apply a reverse-bias voltage (V_R) of 0.5 V, a feebly reverse current starts flowing.
17. Increase V_R in steps of 0.2 V. Current increases first slowly and then rapidly till V_R becomes 20 V. Note the current.
18. Make $V_R = 25$ V. The current increases suddenly. This represents "reverse break-down" stage. Note the current and take out the key at once.

Observations For forward-bias

Range of voltmeter	=V
Least count of voltmeter	=V
Zero error of voltmeter	=V
Range of milli-ammeter	=mA
Least count of milli-ammeter	=mA
Zero error of milli-ammeter	=mA

Table for forward-bias voltage and forward current

<i>Serial No. of Obs. (1)</i>	<i>Forward-bias Voltage V_F (V) (2)</i>	<i>Forward current I_F (mA) (3)</i>
1.	0	0
2.	0.1	0
3.	0.2	0
4.	0.3	0
5.	0.4	0.5
6.	0.6	1
7.	0.8	2
8.	1.0	3
9.	1.2	5
10.	1.4	7.5
11.	1.6	10
12.	1.8	15
13.	2.0	20
14.	2.2	25
15.	2.4	30

For reverse-bias

Range of voltmeter =V

Least count of voltmeter =V

Zero error of voltmeter =V

Range of micro-ammeter = μ A

Least count of micro-ammeter = μ A

Zero error of micro-ammeter =

2. Table for reverse-bias voltage and reverse current

<i>Serial No. of Obs. (1)</i>	<i>Reverse-bias Voltage V_R (V) (2)</i>	<i>Reverse current I_R (μA) (3)</i>
1.	0	0
2.	5.0	1
3.	7.0	2
4.	9.0	3
5.	11.0	4
6.	13.0	5
7.	15.0	7
8.	17.0	9
9.	19.0	11
10.	21.0	13
11.	23.0	15
12.	25.0	25

Result

Junction resistance for forward-bias = 40 ohms

Junction resistance for reverse-bias = 2×10^6 ohms.

Precautions

1. All connections should be neat, clean and tight.
2. Key should be used in circuit and opened when the circuit is not being used.
3. Forward-bias voltage beyond breakdown should not be applied.
4. Reverse-bias voltage beyond breakdown should not be applied.

Sources of error

The junction diode supplied may be faulty.

Activity – 4

Aim

To identify a diode, an LED, a transistor, an IC, a resistor and a capacitor from a mixed collection of such items.

Apparatus and material

Apparatus: Multimeter.

Material: Above mixed collection of items.

Theory

For identification, appearance and working of each item will have to be considered.

1. A diode is a two terminal device. It conducts when forward biased and does not conduct when reverse biased. It does not emit light while conducting. Hence, it does not glow.
2. A LED (light emitting diode) is also a two terminal device. It also conducts when forward biased and does not conduct when reverse biased. It emits light while conducting. Hence, it glow.
3. A transistor is a three terminal device. The terminals represent emitter (E), base (B) and collector (C).
4. An IC (integrated circuit) is a multi-terminal device in form of a chip. [See figure (UM 3482 IC Tone Generator)]
5. A resistor is a two terminal device. It conducts when either forward biased or reverse biased. (Infact there is no forward or reverse bias for a resistor). It conducts even when operated with A.C. voltage.
6. A capacitor is also a two terminal device. It does not conduct when either forward biased or reverse biased. When a capacitor is connected to a D.C. source, then multimeter shows full scale current initially but it decay to zero quickly. It is because that initially a capacitor draw a charge.

The components to be identified are shown in figure.

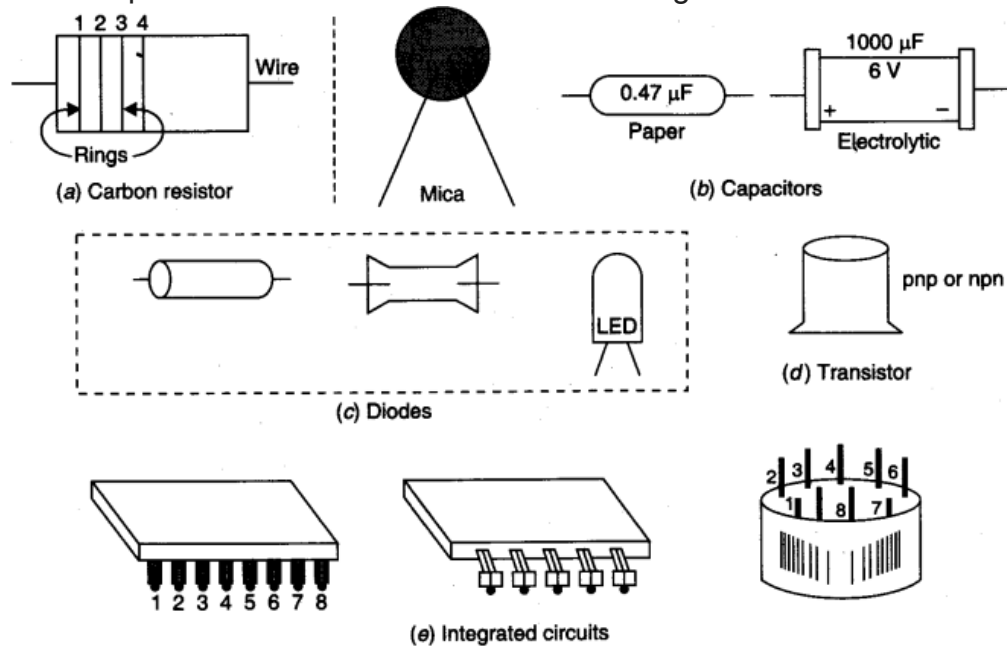


Fig. Some of the commonly available integrated circuits (ICS).

Procedure

1. If the item has four or more terminals and has form of a chip, it is an IC (integrated circuit).
2. If the item has three terminals, it is a transistor.
3. If the item has two terminals, it may be diode, a LED, a resistor or a capacitor.
To differentiate proceed as ahead.
4. Put the selector on resistance R of multimeter for checking the continuity. The probe metal ends are inserted in terminal marked on the multimeter as common and P (or + ve).

Activity – 5

Aim : To observe polarisation of light using two polaroids.

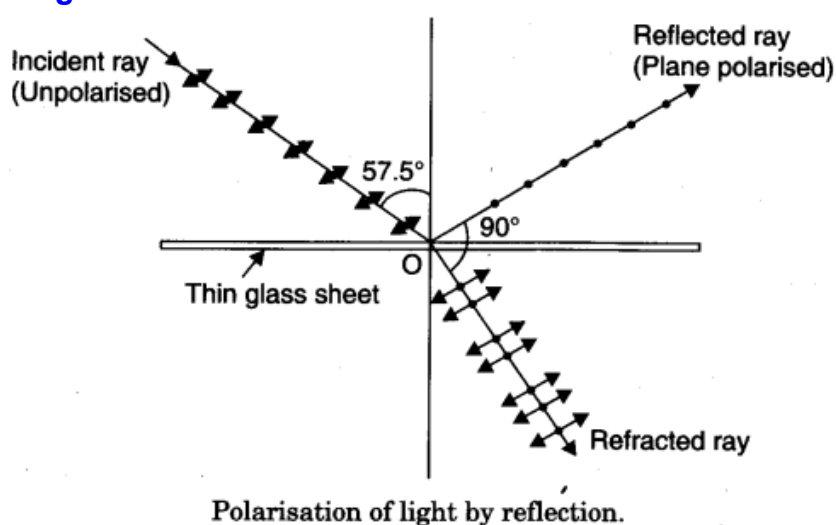
Apparatus

Thin glass sheet, a source giving monochromatic light beam with parallel rays, a polaroid.

Theory

When an unpolarised light is made incident on the interface of two transparent media at polarising angle, the refracted and reflected rays depart from each other at an angle of 90° . The reflected ray is completely plane polarised. It can be tested by a polaroid.

Diagram



Procedure

Keep the thin glass sheet in a horizontal plane surface with a hole under the sheet. Take a beam of monochromatic light having parallel rays and make it incident on the upper face of the glass sheet.

Adjust the angle of incidence to 57.5° .

Observe the reflected rays and the refracted rays. They must make an angle of 90° with each other.

Testing of Polarisation

1. Take a polaroid (P) and keep it in between incident light and your eyes. Rotate it about an axis along incident ray. No change of intensity of light will be detected. It is so because the incident light is unpolarised.
2. Take the second polaroid (A) and place it at a proper distance between polaroid (P) and eye and parallel to it. Light is visible through them.
3. Now rotate the polaroid (A) ranging from 0° to 360° . Keeping the polaroid (P) fix and note the intensity of transmitted light.

4. When polaroid (A) and polaroid (P) at 90° than transmitted light through polaroid (A) will be zero

Result

When the two polaroids are parallel to each other light transmitted through it. But when they are perpendicular, there is no transmitted light. The light obtained through polaroid (P) is plane polarised. The light has transverse nature.

Activity – 6

Aim : To observe diffraction of light due to a thin slit.

Apparatus

Two razor blades, adhesive tapes, a screen a source of monochromatic light (laser pencil) black paper and a glass plate.

Theory

Diffraction is a phenomenon of bending of light around the comers or edges of a fine opening or aperture. Diffraction takes place when order of wavelength is comparable or small to the size of slit or aperture. The diffraction effect is more pronounced if the size of the aperture or the obstacle is of the order of wavelength of the waves. The diffraction pattern arises due to interference of light waves from different symmetrical point of the same wavefront. The diffraction pattern due to a single slit consists of a central bright band having alternate dark and weak bright bands of decreasing intensity on both sides.

For diffraction, $d \sin \theta = n\lambda$

Here d = size of aperture or slit

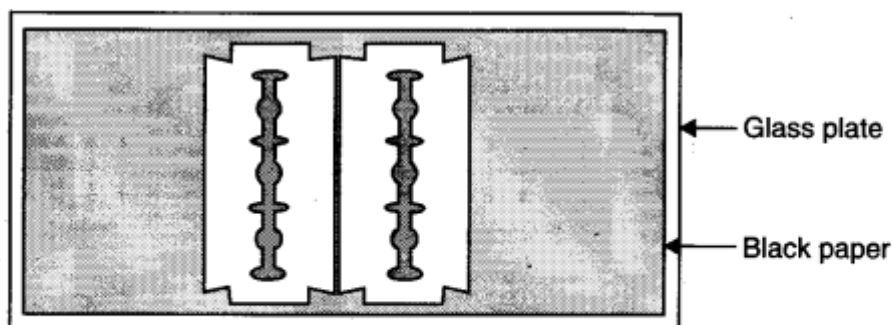
θ = angle of diffraction

n = order of diffraction

λ = wavelength of light.

Procedure

1. Fix the black paper on the glass plate by using adhesive.
2. Place two razor blades so that their sharp edges are parallel and extremely close to each other to form a narrow slit in between.



A thin slit made by using two razor blades, black paper and a glass plate.

3. Cut the small slit in between the sharp edges of blades and place at a suitable distance from a wall or screen of a dark room.
4. Throw a beam of light on the slit by the laser pencil.

Conclusion

When light waves are incident on a slit or aperture then it bends away (spread) at the corners of slit showing the phenomena of diffraction of light.

Precaution

1. Air gaps should not be left between glass plates and black paper.
2. The razor blades should be placed extremely closed as possible.
3. Diffraction pattern should be seen on a wall of a dark room.
4. A point source of monochromatic light like laser torch should be used
5. A diffraction pattern of alternate bright and dark bands is seen on the wall.

