[CLASS XII- PHYSICS - PRACTICAL] 2022-2023

Note :

The record to be submitted by the students at the time of their annual examination has to include:
1. Record of at least 8 Experiments [With 4 from each section], to be performed by the students.
2. Record of at least 8 Activities [With 3 each from section A and section B], to be performed by the students.
3. The Report of the project carried out by the students.

EXPERIMENT – 1

Aim: To determine resistance per cm of a given wire by plotting a graph of potential difference versus current.

Apparatus: A metallic conductor (coil or a resistance wire), a battery, one way key, a voltmeter and an ammeter of appropriate range, connecting wires and a piece of sand paper, a scale.

Formulae Used: The resistance (R) of the given wire (resistance coil) is obtained by Ohm's Law $\frac{V}{I} = R$

Where, V : Potential difference between the ends of the given resistance coil. (Conductor)
I: Current flowing through it.

If l is the length of resistance wire, then resistance per cm of the wire = $\frac{R}{l}$

Observation:

(i) Range:

Range of given voltmeter = 3 v
Range of given ammeter = 500 mA

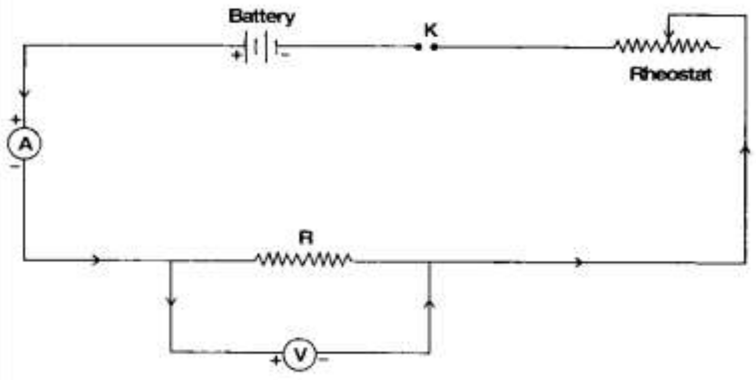


Fig. 1.1

(ii) Least count:

Least count of voltmeter = 0.05v
Least count of ammeter = 10 mA

(iii) Zero error:

Zero error in ammeter, $e_1 = 0$
Zero error in voltmeter, $e_2 = 0$

Ammeter and Voltmeter Readings:

Sr. No.	Ammeter Reading I (A)		Voltmeter Reading, V (v)		$\frac{V}{I} = R$
	Observed	Value	Observed	Value	
1	50	500 mA	16	16x0.05=0.8	1.6 Ω
2	35	350 mA	11	0.55	1.57 Ω
3	32	320 mA	10	0.50	1.56 Ω
4	19	190 mA	6	0.30	1.58 Ω
5	10	100 mA	3	0.15	1.5 Ω

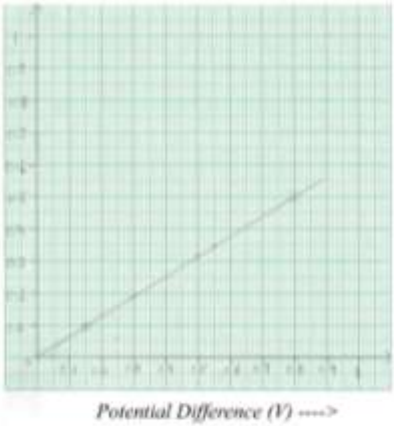
Mean R = 1.56

Length of resistance wire: 28 cm

Graph between potential difference & current:

Scale: X – axis : 1 cm = 0.1 V of potential difference
Y – axis: 1 cm = 0.1 A of current

The graph comes out to be a straight line.



Result: It is found that the ratio V/I is constant, hence current voltage relationship is established i.e. $V \propto I$ or Ohm's Law is verified.

Unknown resistance per cm of given wire = $5.57 \times 10^{-2}\ \Omega\ cm^{-1}$

Precautions: Voltmeter and ammeter should be of proper range.

- The connections should be neat, clean & tight.

Source of Error: Rheostat may have high resistance.
The instrument screws may be loose.

EXPERIMENT – 2

Aim: To find resistance of a given wire using Whetstone's bridge (meter bridge) & hence determine the specific resistance of the material.

Apparatus: A meter bridge (slide Wire Bridge), a galvanometer, a resistance box, a laclanche cell, a jockey, a one-way key, a resistance wire, a screw gauge, meter scale, set square, connecting wires and sandpaper.

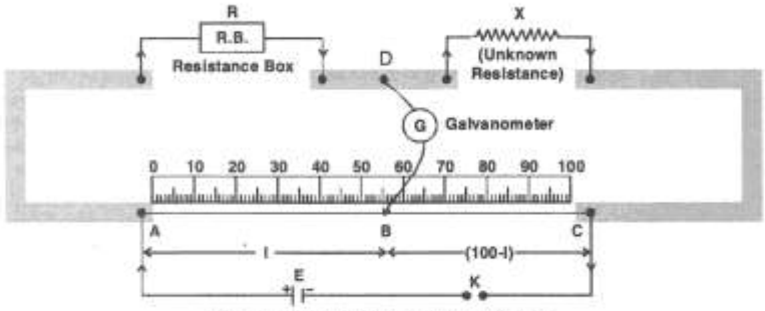


Fig. 2.1 Circuit Diagram - Meter Bridge

Formulae Used:

(i) The unknown resistance X is given by:

$$X = \frac{(100 - l)}{l} \times R$$ Where,

R = known resistance placed in left gap.

X = Unknown resistance in right gap of meter bridge.

l=length of meter bridge wire from zero and upto balance point (in cm)

(ii) Specific resistance (ρ) of the material of given wire is given $\rho = \frac{X \pi D^2}{4L}$

Where,

D: Diameter of given wire

L: Length of given wire.

Observation Table for length (*l*) & unknown resistance, X:

Sr. No.	Resistance from resistance box R (ohm)	Length AB = *l* cm	Length BC = (100-l) cm	Unknown Resistance X = R. $\frac{(100-l)}{l}\Omega$
1	**2**	**41**	**59**	**2.87**
2	**4**	**60**	**40**	**2.66**
3	**6**	**69**	**31**	**2.69**
4	**8**	**76**	**24**	**2.52**

Table for diameter (D) of the wire:

Sr. No.	Linear Scale Reading (N) mm	Circular Scale Reading		Observed diameter D = N + n x L.C. mm
		No. of circular scale divisions coinciding (n)	Value n x (L.C.) mm	
1	**0**	**34**	**0.34**	**0.34**
2	**0**	**35**	**0.35**	**0.35**
3	**0**	**36**	**0.36**	**0.36**
4	**0**	**35**	**0.35**	**0.35**

Observations:

- Least count of screw gauge: 0.001 cm

Pitch of screw gauge: 0.1 cm

Total no. of divisions on circular scale: 100

Least Count = $\frac{Pitch}{No.\,of\;\;divisions\,on\,circular\;\;scale}$

$\therefore LC = 0.001\,cm$

- **Length of given wire, L = 25cm**

  Calculation:

- For unknown resistance, X:

  Mean X = $\frac{X_1 + X_2 + X_3 + X_4}{4} = 2.68\Omega$

- Mean diameter, D = $\frac{D_1 + D_2 + D_3 + D_4}{4} = 0.035\,cm$

- Specific Resistance, $\rho = X.\frac{\pi D^2}{4L} = 1.03\times10^{-4}\,\Omega\,cm$

Result: Value of unknown resistance = 2.68 Ω

Specific resistance of material of given wire $= 1.03\times10^{-4}\,\Omega\,cm$

Precautions: All plugs in resistance box should be tight. Plug in key, K should be inserted only while taking observations.

Sources of Error: Plugs may not be clean.

Instrument screws maybe loose.

EXPERIMENT – 3

Aim: To verify the laws of combination (series & parallel) of resistances using meter bridge (slide Wire Bridge)

Apparatus: A meter bridge, laclanche cell, a galvanometer, a resistance box, a jockey, two resistances wires, set square, sand paper and connecting wires.

(i) In series

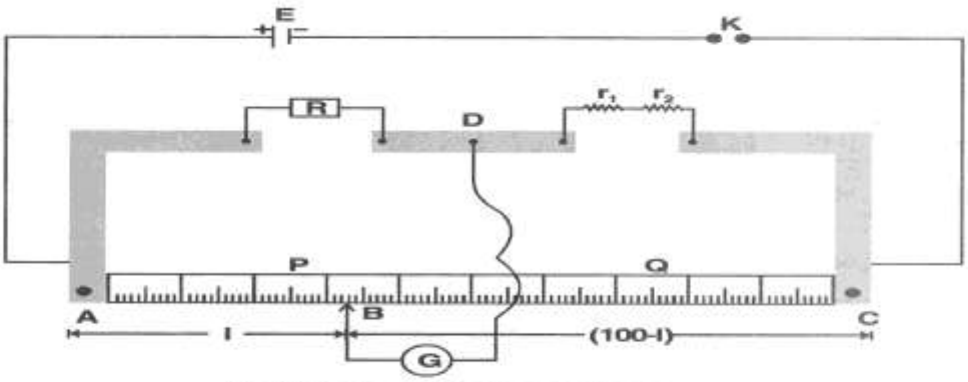


Fig. 3.1 Series combination of resistances

(ii) In parallel

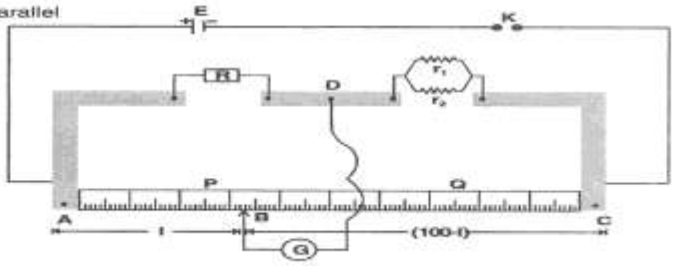


Fig. 3.2 Parallel combination of resistances

Observations: Table for length (l) & unknown resistance (r):

Resistant Coil	**Obs. No.**	**Resistance from resistance box, R (ohm)**	**Length AB = *l* (cm)**	**Length BC = 100 – *l* (cm)**	**Resistance r = $\frac{100-l}{l}.R$**	**Mean Resistant (ohm)**
r_1 only	1	0.5	35	65	0.92	
	2	1.0	43	57	1.32	1.24
	3	1.5	50	50	1.5	
r_2 only	1	0.5	30	70	1.16	
	2	1.0	38	62	1.63	1.51
	3	1.5	46	54	1.76	
r_1 & r_2 in series	1	1.3	34	66	2.52	
	2	2.2	45	55	2.68	2.72
	3	3.5	54	46	2.97	
r_1 & r_2 in parallel	1	2	75	25	0.67	
	2	3	82	18	0.66	0.66
	3	4	86	14	0.65	

Calculations:

(i) In Series: Experimental value of $R_S = 2.72\ \Omega$

Theoretical value of $R_S = r_1 + r_2 = 2.75\ \Omega$

(ii) In parallel: Experimental value of $R_P = 0.66\ \Omega$

Theoretical value of $R_P = \frac{r_1 r_2}{r_1 + r_2} = 0.68\Omega$

Result: Within limits of experimental error, experimental & theoretical values of R_S are same. Hence the law of resistance in series i.e. $R_S = r_1 + r_2$ is verified. (1) Within limits of experimental error, experimental & theoretical values of R_P are same. Hence law of resistances in parallel i.e. $R_S = \frac{r_1 r_2}{r_1 + r_2}$ is verified.

Precautions:

(i) The connections should be neat, clean & tight.
(ii) Move the jockey gently over the wire & don't rub it.
(iii) All plugs in resistant box should be tight.

Sources of Error:

(i) The plugs may not be clean.
(ii) The instrument screws maybe loose.

EXPERIMENT – 4

Aim: To determine the resistance of a galvanometer by half-deflection method & to find its figure of merit.

Apparatus: A Weston type galvanometer, a voltmeter, a battery, a rheostat, two resistance boxes (10,000 Ω and 500 Ω), two one-way keys, a screw gauge, a meter scale, connecting wires and a piece of sandpaper.

Circuit Diagram : (i) For half deflection method

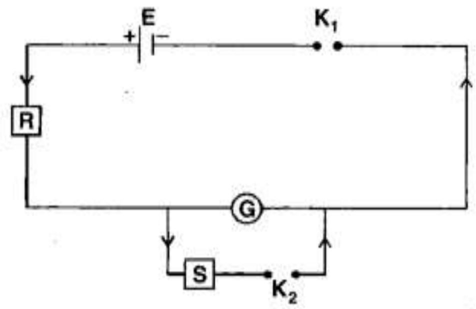


Fig. 7.1 : Resistance of galvanometer

(ii) For figure of merit

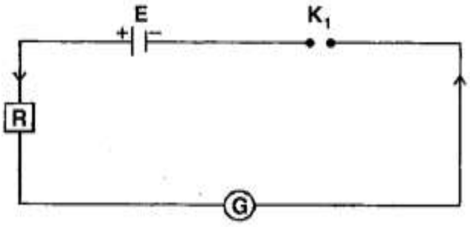


Fig. 7.2 : Figure of merit

Formulae Used:

(i) The resistant of the given galvanometer as found by half-deflection method:

$$G = \frac{R.S}{R - S}$$

Where R: resistance connected in series with the galvanometer
S: shunt resistance

(ii) Figure of merit: $k = \frac{E}{(R+G)\,\theta}$

Where E : emf of the cell
θ : deflection produced with resistance R.

For Half Deflection:

S. No.	Resistance R (Ω)	Deflection in galvanometer (θ)	Shunt resistance S (Ω)	Half Deflection $\theta/2$	Galvanometer Resistance $G = \frac{RS}{R-S}\Omega$
1	4500	30	70	15	71.1
2	9500	14	70	7	70.5
3	5200	26	70	13	70.9
4	5700	24	70	12	70.8

Mean G = 70.8 Ω

Calculation: Mean G = 70.8 Ω

(i) For G : Calculate G using formula.
Take mean of all values of G recorded in table.
(ii) For k: Calculate k using formula & record in table.
Take mean of values of k.

Result:

For Figure of Merit:

S. No.	Emf of the cells E (v)	Resistance from R. B. R Ω	Deflection θ (div.)	Figure of Merit $K = \frac{E}{(R+G)\theta}$
1	1.5 x 2 = 3	4500	30	2.18×10^{-5}
2	3	9500	14	2.23×10^{-5}
3	3	5200	26	2.18×10^{-5}
4	3	5700	24	2.16×10^{-5}

Mean K = 2.19×10^{-5} A/div.

(i) Resistance of Galvanometer by half – deflection method:

$G = 70.8\,\Omega$

(ii) Figure of merit, $k = 2.19 \times 10^{-5}$ A/div

Precautions:

(i) All the plugs in resistance boxes should be tight.

(ii) The emf of cell or battery should be constant.

(iii) Initially a high resistance from the resistance box (R) should be introduced in the circuit. Otherwise for small resistance, an excessive current will flow through the galvanometer or ammeter & damage them.

Sources of error:

(i) Plug of the resistant boxes may not be clean.

(ii) The screws of the instruments maybe loose.

(iii) The emf of the battery may not be constant.

EXPERIMENT – 5

Aim: To convert the given galvanometer (of known resistance & figure of merit) into an ammeter of desired range & to verify the same.

Apparatus: A Weston type galvanometer whose resistance & figure of merit are given, a constantan or manganin wire, a battery, one-way key, a rheostat, a milli-ammeter, connecting wires, sand paper etc.

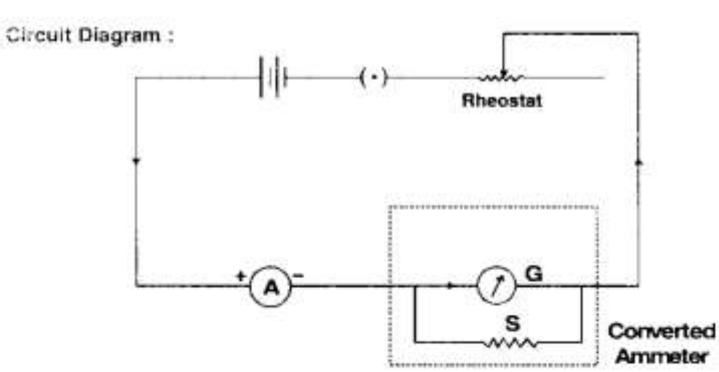


Fig. 7(A) - 1 : Converted Galvanometer into an ammeter.

Formulae Used:

To convert a galvanometer which gives full scale deflection for current I_G into an ammeter of range O to I_O amperes, the value of required shunt is given by: $S = \left(\frac{I_G}{I_o - I_G}\right)G$

Required shunt resistant S is made using a uniform wire whose, specific resistance is ρ (known) & its length:

$$l = \frac{\pi r^2 S}{\rho}$$

Observations: Given resistance of galvanometer, $G = 70.8\,\Omega$

Given value of figure of merit, $k = 2.19 \times 10^{-5}$ A div^{-1}

Total no. of divisions on either side of zero, $N_o = 30$

Current for full scale deflection, $I_G = N_o \times k = 6.57 \times 10^{-4}$ A

a) Calculation of value of shunt resistance:

* Required range of converted ammeter, $I_o = 3$A

* Value of shunt resistance,

Table for Verification:

S. No.	Galvanometer Reading		Ammeter Reading $I_2 = n \times LC$	Error $(I_2 - I_1)$ A
	Deflection θ	Current $I_1 = \theta \times LC$		
1	3	3 x 0.1 = .3	6 x .05 = 0.3	0.0
2	5	0.5	11 x 0.05 = .55	0.05
3	7	0.7	15 x 0.05 = .75	0.05
4	9	0.9	19 x 0.5 = .95	0.05

S = $\left(\frac{I_G}{I_o - I_G}\right) \times G = 0.0155\,\Omega$

* Computing the length of the wire to make resistance of 0.155 Ω
b) Observations for diameter of the wire:
(i) Pitch of screw gauge, p = 1 mm
(ii) No. of division of circular scale = 100
(iii) Least count, a = 0.01 mm
(iv) Zero error, e = 0.0 mm
(v) Diameter of the wire = 0.98 mm, Radius = 0.049 cm
c) Specific resistance of material of wire, $\rho = 1.92 \times 10^{-6}\ \Omega cm$
d) Required length of the wire,

$$l = S \times \frac{\pi r^2}{\rho} = \frac{0.0155 \times 3.14 \times (0.049)^2}{1.72 \times 10^{-6}} \text{ cm} = 60.8 \text{ cm}$$

Verification: Checking the performance of the converted ammeter:
Current indicated by full scale deflection (N_o) of converted ammeter. I_o = 3A
Least count of converted ammeter, $k' = \frac{I_o}{N_o} = 0.1\ A/div.$

Result:

- Current I_G for full scale deflection = 6.57×10^{-4} A
- Resistance of shunt required to convert the galvanometer into ammeter, S = 0.0155 Ω
- Required length of wire, l = 60.8 cm
- As error $l' - l$ is very small, conversion is verified.

Precautions & Sources of Error:

(i) All connections should be neat & tight.
(ii) The diameter of the wire for making shunt resistance should be measured accurately for diameter is taken in two mutually perpendicular directions.
(iii) The terminal of the ammeter marked positive should be connected to positive pole of the battery. Also ammeter should be in series with circuit.

EXPERIMENT – 6

Aim: To find the value of *v* for different values of 'u' in case of a concave mirror & to find its focal length.

Apparatus: An optical bench with three uprights. Concave mirror, a mirror holder, two optical needles, a knitting needle & a half – meter scale.

Ray Diagram :

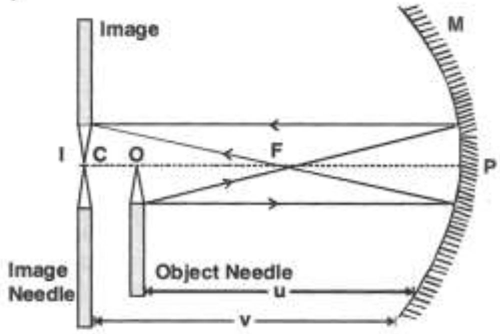


Fig. 9.1 : Focal Length of Concave Mirror

Formulae Used: The mirror formula is:

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

We have, $f = \frac{uv}{u+v}$

Where, f = focal length of concave mirror.
u = distance of object needle from pole of mirror.
v = distance of image needle from pole of mirror.

Observation:
Rough focal length of given concave mirror = 10.9 cm
Actual length of the knitting needle, x = 15 cm

Observed distance between the mirror & object needle when knitting needle is placed between them, y = 15.2 cm.
Observed distance between the mirror & image needle when knitting needle is placed between them, z = 15.8 cm.
Index error for u, $e_1 = y - x = -0.2$ cm
Index error for v, $e_2 = z - x = -0.8$ cm

Sr. No.	Position			Corrected Distance		1/ *u* (cm^{-1})	1/*v* (cm^{-1})
	Concave Mirror P (cm)	Object Needle O	Image Needle I	PO *u* cm	PI v cm		
1	0.0	18	26	17.8	25.2	0.056	0.037
2	0.0	17	30.3	16.8	29.5	0.06	0.034
3	0.0	16	33.4	15.8	32.6	0.063	0.031
4	0.0	26	18	25.8	17.2	0.038	0.058
5	0.0	30.3	17	30.1	16.2	0.033	0.061
6	0.0	33.4	16	33.2	15.2	0.030	0.065

Calculations:

(i) <u>$u - v$ graph:</u>

Explanation: from mirror formula applied to point A:

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

As $u = v$, $\frac{1}{f} = \frac{2}{u}$ *or* $\frac{2}{v}$ *and* $f = \frac{u}{2}$ *or* $\frac{v}{2}$

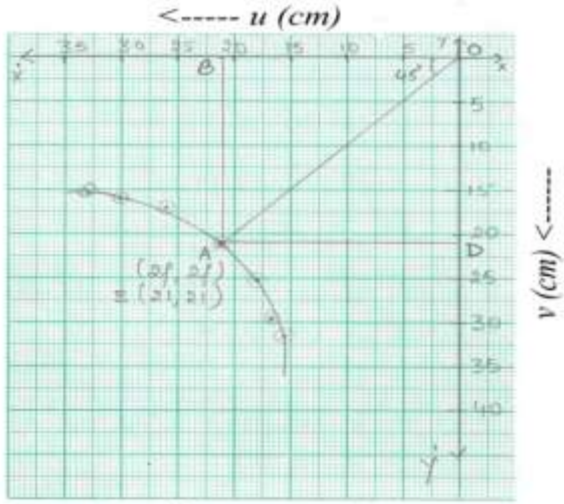
Hence, $f = \frac{-OD}{2} = \frac{-21}{2} = -10.5\,cm$

Graph Scale: X' axis: 1 cm = 5 cm of u

Y' axis: 1 cm = 5 cm of v

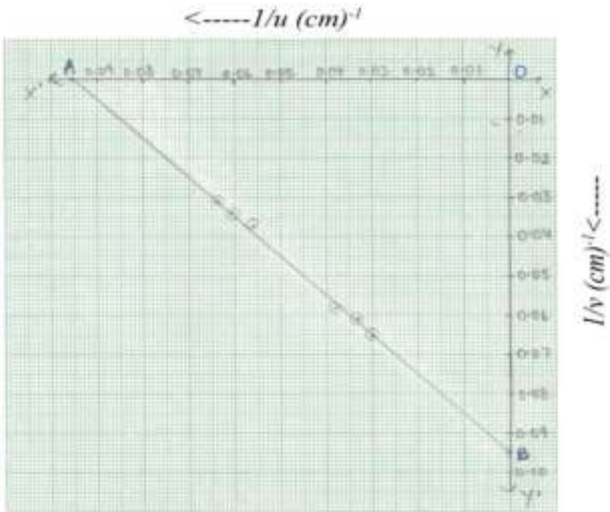
Also $f = \frac{-OB}{2} = -10.5cm$

<u>Mean value of f = -10.5 cm</u>



Graph between u & v

(ii) $\frac{1}{u}$ *and* $\frac{1}{v}$ *graph*:



Graph between 1/u and 1/v

The focal length, $f = \frac{-1}{OA} = \frac{-1}{OB} = -10.47cm$

Graph Scale: X' axis: 1 cm = 0.01 cm^{-1} *of* $\frac{1}{u}$

Y' axis: 1 cm = 0.01 cm^{-1} *of* $\frac{1}{v}$

Result: The focal length of the given concave mirror:
(i) From $u - v$ graph is : $f = -10.5$ cm
(ii) From $\frac{1}{u} - \frac{1}{v}$ graph is: $f = -10.47$ cm

Precautions:
(i) The uprights should be vertical.
(ii) Tip-to-tip parallax should be removed between the needle I and image of needle O.
(iii) To locate the position of the image the eye should be at least 30 cm away from the needle.

Sources of Error: * The uprights may not be vertical. * Parallax removal may not be perfect

EXPERIMENT – 7

Aim: To find the focal length of a convex mirror using a convex lens.
Apparatus: An optical bench with four uprights (2 fixed upright in middle two outer uprights with lateral movement), convex lens, convex mirror, a lens holder, a mirror holder, 2 optical needles (one thin, one thick), a knitting needle, a half meter scale.

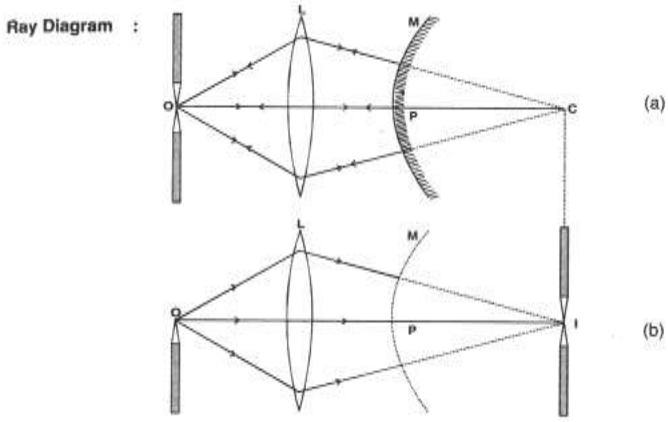


Fig. : 10.1 Focal Length of Convex Mirror

Formula Used:

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

Where R is radius of curvature of the mirror.

Observation:

(i) Actual length of knitting needle, x = 15 cm.
(ii) Observed distance between image needle I and back of convex mirror, y = 15 cm
(iii) Index error = y - x = 15 – 15 = 0 cm No index correction

Observation Table:

S. N.	Position of:				Radius of Curvature MI (cm)
	Object needle 0 (cm)	Lens L cm	Mirror M cm	Image needle I (cm)	
1	25	50	56	70.5	14.5
2	28.5	50	60	73.3	13.3
3	31.5	50	65	78.4	13.4
4	30.5	50	60	74	14

Mean R = 13.8

Calculation:

Mean corrected MI = R = 13.8 cm $f = \frac{R}{2} = 6.9\,cm$

Result:

The focal length of the given convex mirror = 6.9 cm

Precautions:

(i) The tip of the needle, centre of the mirror & centre of lens should be at the same height.
(ii) Convex lens should be of large focal length.
(iii) For one set of observations, when the parallax has been removed for convex lens alone, the position of the lens & needle uprights should not be changed.

EXPERIMENT – 8

Aim: To find the focal length of a convex lens by plotting a graph:

(i) between u and v

(ii) between $\frac{1}{u}$ *and* $\frac{1}{v}$

Apparatus: An optical bench with three uprights, a convex lens, lens holder, two optical needles, a knitting needles & a half-metre scale.

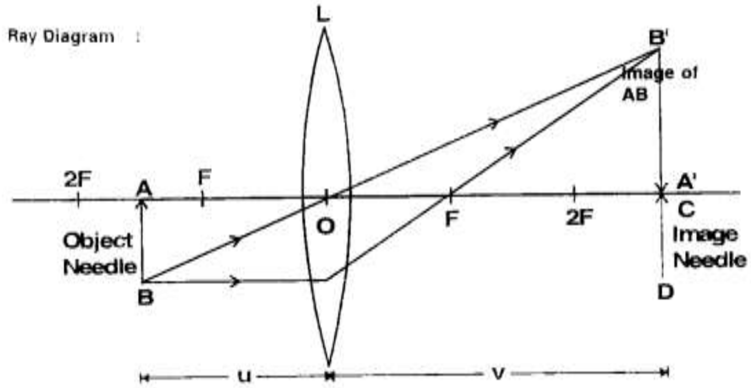


Fig. 11.1 Focal Length of Convex Lens

Formula Used:

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

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

Where *f:* focal length of convex lens

u: distance of object needle from lens' optical centre.

v: distance of image needle from lens' optical centre.

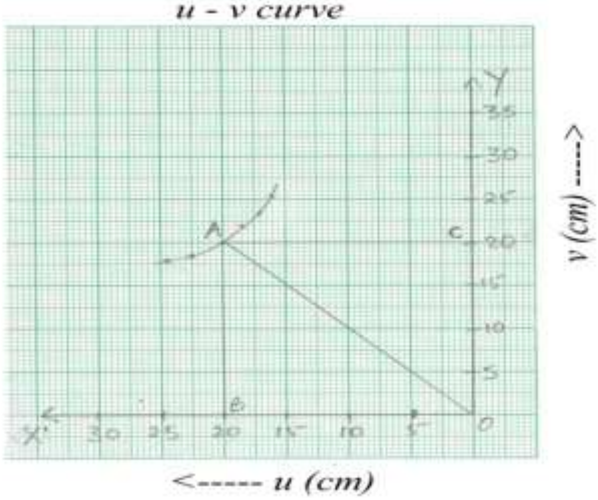
Observations:

(i) Rough focal length of the lens = 10 cm
(ii) Actual length of knitting needle, x = 15 cm.
(iii) Observed distance between object needle & the lens when knitting needle is placed between them, y = 15.2 cm.
(iv) Observed distance between image needle & the lens when knitting needle is placed between them, z = 14.1 cm.
(v) Index correction for the object distance u, x – y = – 0.2 cm
(vi) Index correction for the image distance v, x – z = +0.9 cm

Observation Table:

S. No.	Position of: (cm)			*u (cm)*	*v (cm)*	*1/v* (cm^{-1})	*1/u* (cm^{-1})
	Object needle	Lens	Image needle				
1	66	50	26	16	24	0.041	0.062
2	67	50	27	17	23	0.043	0.058
3	68	50	28	18	22	0.045	0.055
4	70	50	30	20	20	0.05	0.05
5	75	50	33	23	17	0.058	0.043
6	80	50	34	24	16	0.062	0.041

u - v curve



Calculation of focal length by graphical method:

(i) ***u – v* graph:** The graph is a rectangular hyperbola:

Scale: X' axis: 1 cm = 5 cm of *u*

Y' axis: 1 cm = 5 cm of *v*

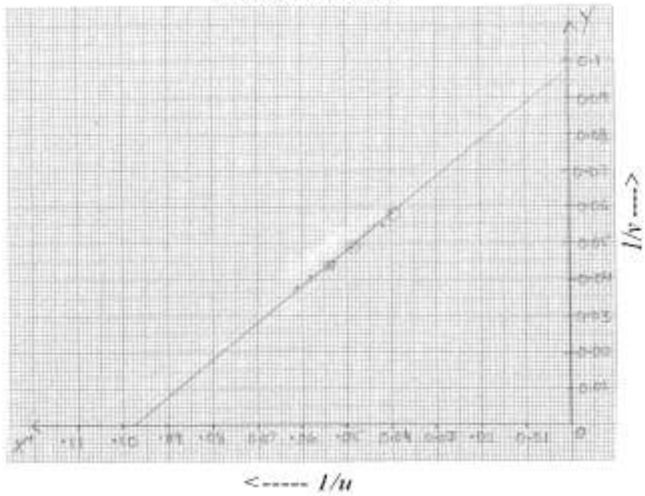
AB = AC = 2*f* or OC = OB = 2*f*

$\therefore f = \dfrac{OB}{2}$ *and also* $f = \dfrac{OC}{2}$

$\therefore$ Mean value of *f* = 10.1 cm.

(ii) $\dfrac{1}{u} - \dfrac{1}{v}$ *graph*: The graph is a straight line.

1/u vs 1/v Curve



Scale; X' axis: 1 cm = 0.01 cm^{-1} of $\dfrac{1}{u}$

Y' axis: 1 cm = 0.01 cm^{-1} of $\dfrac{1}{v}$

Focal length, $f = \dfrac{1}{OP} = \dfrac{1}{OQ} = 10.2 cm.$

Result:

(i) From *u*-*v* graph is, *f = 10.1 cm*

(ii) From $\dfrac{1}{u} - \dfrac{1}{v}$ graph is, *f = 10.2 cm*

Precautions:

(i) Tips of object & image needles should be at the same height as the centre of the lens.

(ii) Parallax should be removed from tip-to-tip by keeping eye at a distance at least 30 cm. away from the needle.

(iii) The image & the object needles should not be interchanged for different sets of observations.

EXPERIMENT – 9

Aim: To find the focal length of a concave lens using a convex lens.

Apparatus: An optical bench with four uprights, a convex lens (less focal length), a concave lens (more focal length), two lens holder, two optical needles, a knitting needle & a half – metre scale.

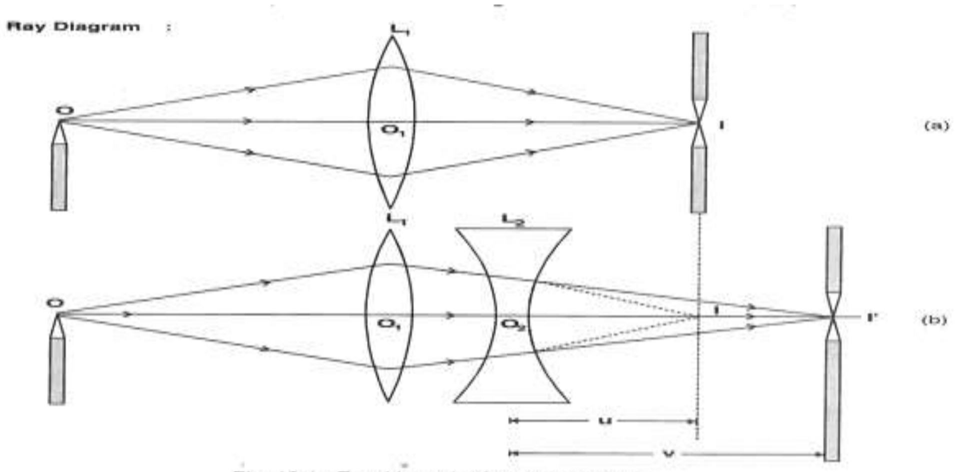


Fig. 12.1 : Focal Length of a concave lens

Formulae Used: From lens formula, we have:

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

Observations:

Actual length of knitting needle, x= 15 cm.
Observed distance between object needle & the lens when knitting needle is placed between them, y = 15 cm.
Observed distance between image needle & the lens when knitting needle is placed between them, z = 15 cm.
Index correction for u = x – y = 0 cm
Index correction for v = x – z = 0 cm

Observation Table:

S. No.	Position of (cm)					$u = IL_2$	$v = I'L_2$	$f = \frac{uv}{u-v}$
	0 (cm)	L_1 at O_1	I	L_2	I'			
1	29	50	75	69	78	6.0	9.0	–18.0
2	27	50	71.5	65	77.5	6.5	12.5	–13.54
3	25	50	70.5	65	72.8	5.5	7.8	–18.64
4	28	50	71.3	63	71.2	8.3	8.2	–17.45

Calculations:

Mean $f = \frac{f_1 + f_2 + f_3 + f_4}{4}$

= – 16.9 cm $\approx$ -17cm.

Result: The focal length of given concave lens = – 17 cm.

Precautions:

(i) The lenses must be clean.
(ii) A bright image should be formed by lens combination.
(iii) Focal length of the convex lens should be less than the focal length of the concave lens, so that the combination is convex.

EXPERIMENT – 10

Aim: (i) To determine angle of minimum deviation for a given prism by plotting a graph between angle of incidence & angle of deviation.

(ii) To determine the refractive index of the material (glass) of the prism.

Apparatus: Drawing board, a white sheet of paper, prism, drawing pins, pencil, half metre scale, office pins, graph paper & protector.

Diagram

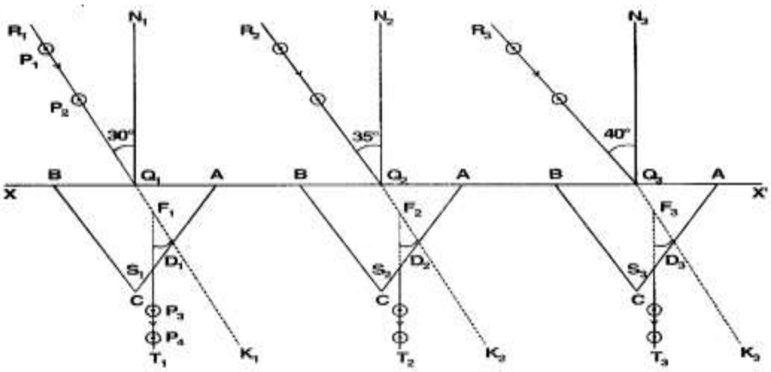


Fig. 13.1 : Refraction through prism at different angles

Formulae Used:

The refractive index, μ of the material of the prism is given by:

$$\mu = \frac{\sin\left(\frac{A+Dm}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

Where D_m is the angle of minimum deviation & A is the angle of prism.

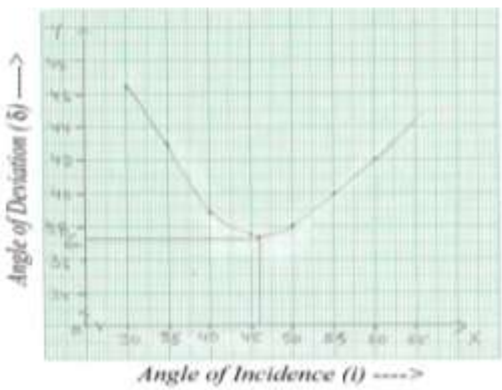
Calculations:

From graph between angle of incidence, $\angle i$ and angle of deviation, we get the value of D_m (angle of minimum deviation): $D_m = 37.8^o$

Thus, $\mu = \frac{\sin\left(\frac{A+Dm}{2}\right)}{\sin\left(\frac{A}{2}\right)} = \frac{\sin\left(97.8^o/2\right)}{\sin 30^o}$

$\mu = 1.5077$

S. No.	Angle of Incidence $\angle i$	Angle of Deviation $\angle \delta$
1	35°	43°
2	40°	38.8°
3	45°	37.8°
4	50°	38°
5	55°	40°
6	60°	42°



Result:

(i) From $\angle i - \angle D$ graph we see that as $\angle i$ increases, $\angle D$ first decreases, attains a minimum value (D_m) & then again starts increasing for further increase in $\angle i$.

(ii) Angle of minimum deviation = $D_m = 37.8^o$

(iii) Refraction index of material of prism, $\mu = 1.5077$

Precautions:

(i) The angle of incidence should be between $30^o - 60^o$.

(ii) The pins should be fixed vertical.

(iii) The distance between the two pins should not be less than 8 cm.

Sources of Error:

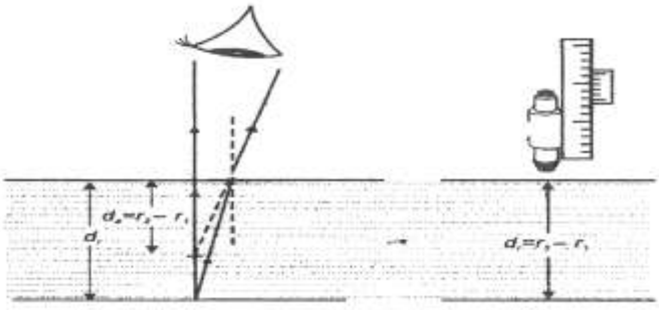
(i) Pin pricks may be thick.

(ii) Measurement of angles maybe wrong.

EXPERIMENT – 11

Aim: To determine the refractive index of a glass using travelling microscope.

Apparatus: A marker, glass slab, travelling microscope, lycopodium powder.



Formulae Used:

Refractive index $\mu = \frac{real\ depth}{apparent\ depth} = \frac{r_3 - r_1}{r_2 - r_1}$

Observations:

Least count of travelling microscope = 0.001 cm or 0.01 mm

Mean values: $r_1 = 0$ mm $r_2 = 6.81$ mm $r_3 = 10.25$ mm

Observations: Reading of Microscope focused on:

S. No.	Mark without slab $r_1 = M + n \times LC$ min	Mark with slab on it $r_2 = M + n \times LC$ min	Powder on top of slab $R_3 = M + n \times LC$ min
1	0	6.5 + 29 x 0.01 = 6.79mm	10 + 23 x 0.01 = 10.23mm
2	0	6.5 + 31 x 0.01 = 6.81mm	10 + 25 x 0.01 = 10.25mm
3	0	6.5 + 33 x 0.01 = 6.83mm	10 + 27 x 0.01 = 10.27mm

Calculations:

Real depth = $d_r = r_3 - r_1$ = Mean d_r = 10.25 mm

Apparent depth = $d_a = r_2 - r_1$

Mean d_a = 6.81 mm

$\therefore$ Refractive index, $\mu = \frac{real\ depth}{apparent\ depth} = \frac{d_r}{d_a}$ $\therefore \mu = 1.52$

Result:

The refractive index of the glass slab by using travelling microscope is determined as 1.52 = μ

Precautions:

(i) Microscope once focused on the cross mark, the focusing should not be disturbed throughout the experiment. Only rack and pinion screw should be turned to move the microscope upward.

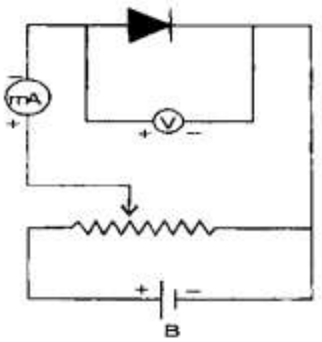
(ii) Only a thin layer of powder should be spread on top of slab.

(iii) Eye piece should be so adjusted that cross-wires are distinctly seen.

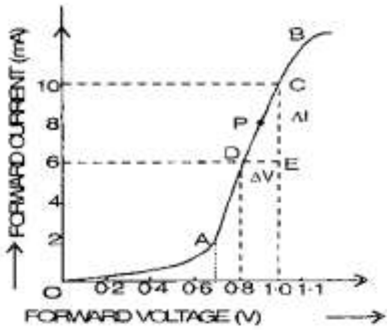
EXPERIMENT – 12

Aim: To draw the I – V characteristics curve of *p-n* junction in forward bias & reverse bias.

Apparatus: A *p-n* junction semi-conductor diode, a three volt battery, a high resistance, a rheostat, a voltmeter (0-3v), a milli ammeter (0-.30 mA), one – way key, connecting wires.



a



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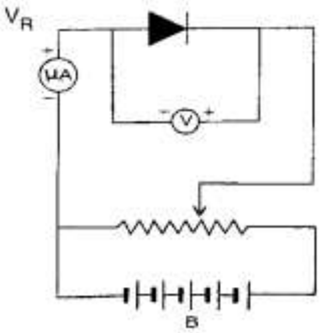
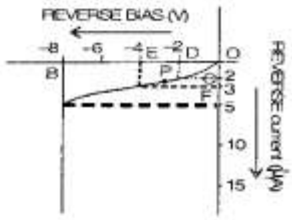


a



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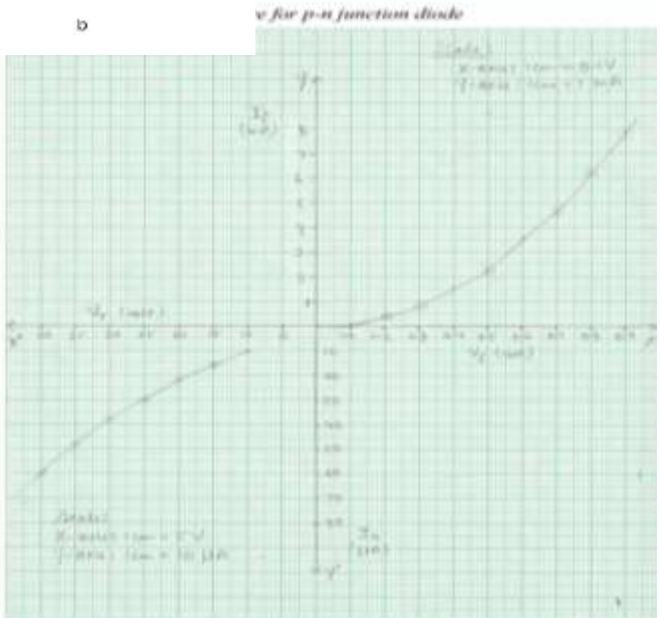


Observations:

Least count of voltmeter = 0.02 & 1 v/div Zero error = –

Least count of milli-ammeter = 0.2 mA/div Zero error = –

Least count of micro-ammeter = 2 μ A/div Zero error = –

Observation Table:

S. No.	Forward Bias Voltage (V)	Forward Current (mA)	Reverse bias Voltage (V)	Reverse Current (μ A)
1	10 x 0.02 = 0.20	2 x 0.2 = 0.4	10 x 1 = 10	5 x 2 = 10
2	0.30	4 x 0.2 = 0.8	15	16
3	0.40	6 x 0.2 = 1.6	20	22
4	0.50	11 x 0.2 = 2.2	25	30
5	0.60	18 x 0.2 = 3.6	30	38
6	0.70	23 x 0.2 = 4.6	35	48
7	0.80	31 x 0.2 = 6.2	40	60
8	0.90	39 x 0.2 = 7.8	45	72

Calculations:

Graph is plotted between forward – bias voltage (V_F) (on x-axis) and forward current, I_F (on y – axis)
Scale: X – axis: 1 cm = V of V_F Y – axis: 1 cm = mA of I_F
Graph is plotted between reverse bias voltage, V_R (along X' axis) and reverse current, I_R (along Y' axis).
Scale: X' axis = 1 cm = V of V_R Y' axis = 1 cm = μA of I_F

Result: The obtained curves are the characteristics curves of the semi-conductor diode.

Precautions:
(i) All connections should be neat, clean & tight. (ii) Key should be used in circuit & opened when the circuit is not being used. (iii) Forward bias voltage beyond breakdown should not be applied.
Sources of error: The junction diode supplied maybe faulty.

NOTE: Beside Practical File ONE Activity file with SIX Activities (A-3, A-4, A-6 and B-8, B-11, B-12 From Any Physics Practical File) and ONE Project Report has to be made by each student from the Elite Manual.

ACTIVITIES

Section - A

Activity 1

Object : **To measure the resistance and impedance of an inductor with or without iron core.**

Apparatus : Inductor coil, iron core, resistance box, battery eliminator, step down transformer, ammeters d.c. and a.c. of range 0 to 0.3 A, voltmeters a.c. and d.c. of 0 to 5 V, one way key, connecting wires.

Circuit Diagram:

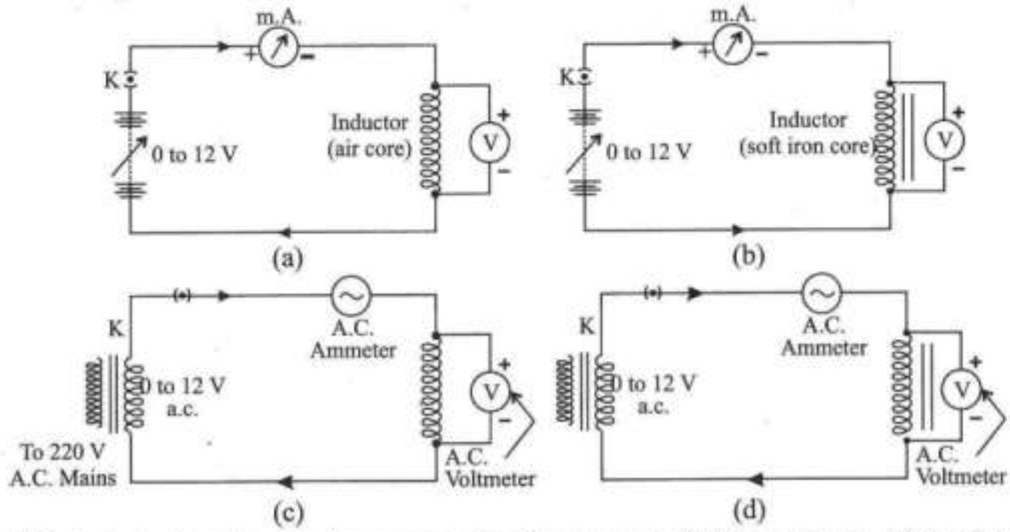


Fig. 1.1 : Inductor in a d.c. circuit measurement of resistance with (a) an air core, (b) a soft iron core. Inductor in an a.c. circuit measurement of impedance with (c) air core (d) soft iron core.

Theory :

(i) D.C. circuit :

(a) Resistance of coil without iron core

$$R = \frac{V}{I}$$

(b) Resistance of coil on introducing soft iron core

$$R' = \frac{V'}{I'} = \frac{\text{d.c. voltage across inductor}}{\text{direct current through the inductor}}$$

(ii) A.C. circuit :

(a) Impedance of the coil without iron core

$$Z = \frac{V_{a.c.}}{I_{a.c.}} = \frac{\text{a.c. voltage across the inductor}}{\text{alternating current through the inductor}}$$

(b) Impedance of the coil on introducing soft iron core

$$Z' = \frac{V'_{a.c.}}{I'_{a.c.}} = \frac{\text{a.c. voltage across the inductor with core}}{\text{alternating current through the inductor with core}}$$

Procedure :

(a) Measurement of resistance of inductor :

(i) Without iron core

(i) Arrange the apparatus and make connections as shown in Fig. 1.1 (a) keeping the key K open.

(ii) Connect a 6 V d.c. source of supply (an eliminator) and d.c. instruments ammeter in series with inductor and voltmeter in parallel with it.

(iii) Ensure that the polarities of ammeter and voltmeter are rightly connected.

(iv) Adjust the eliminator to 2 Volt and switch on the eliminator.Plug in the key. Measure the d.c. current through the conductor and d.c. voltage across the inductor.

(v) Set the eliminator to 4 V and 6 V in succession and record the d.c. current through the inductor and potential drop across it.

(ii) With core of soft iron introduced in the inductor coil.

(vi) Introduce the given core of soft iron inside the coil such that the core is fully inside the coil.

(vii) Repeat the step (iv) and (v) and record your observations.

(b) Measurement of Impedance of Inductor

(i) Without soft iron core

(viii) Use the step down transformer with tappings of 2 V, 4 V and 6 V and a.c. instruments voltmeter (0 to 5 V) and ammeter of range 0.3 A and connect them as shown in circuit diagram, Fig. 1.1 (b).

(ix) Repeat the step (iv) and step (v) and record your observations. Now switch off the supply.

(ii) With core of soft iron introduced in the inductor coil.

(x) Introduce the core of soft iron inside the coil such that the core is fully inside the coil. Switch on the transformer.

(xi) Repeat the steps (iv) and (v) and record observation as detailed below.

Observations : **(a) For measurment of Resistance of Inductor coil.**

Range of d.c. voltmeter = 0 to V

Range of d.c. ammeter = 0 to ....A

Least count of voltmeter = ... V

Least count of ammeter = ... A

Zero error if any should be adjusted to zero by adjusting the pointer in voltmeter and ammeter.

Table 1.1

No. of Obs.	Eliminator setting	Without Iron Core			With iron core		
		Readings		R = V/I (Ohm)	Readings		R' = V'/I' (Ohm)
		Volt-meter V' (Volt)	Ammeter I (ampere)		Volt-meter V' (Volt)	Ammeter I (ampere)	
1.	2v						
2.	4v						
3.	6v						

(b) For measurment of Impedance of Inductor Coil

Range of a.c. voltmeter = 0 to V

Range of a.c. ammeter = 0 to ....A

Least count of instruments (in a.c. instruments the divisions are non-uniformly spaced, therefore observations, accuracy may vary from one observation to other.

Zero error of instruments : The pointer is adjusted to zero when no current is passed.

Table 1.2

No. of Obs.	Transformer setting	Without Iron Core			With iron core		
		Readings		Impedance R = V/I (Ohm)	Readings		Impedance Z' = V'/I' (Ohm)
		Volt-meter V' (Volt)	Ammeter I (ampere)		Volt-meter V' (Volt)	Ammeter I (ampere)	
1.							
2.							
3.							
4.							
5.							
Mean value of Z = ... Ohm				Mean value of Z' = ... Ohm			

Conclusion :

(a) For flow of direct current d.c., the resistance of the inductor coil is about the same with and without soft iron core, ... ohm and .... ohm respectively.

(b) For flow of alternating current a.c. (50 Hertz).

(i) The impedance of the inductor coil is .... ohm.

(ii) On introducing the iron core, the impedance of the inductor comes to be = ... ohm.

There is a marked increase in impedance on inserting the iron core in the coil. With iron core, the magnetic field hence magnetic flux for a given current or self inductance increases considerably.

Precautions :

(i) The inductor coil should have sufficient number of turns and suitable value of radius.

(ii) Measuring instruments used should be of appropriate range and low least counts.

(iii) Zero error of instruments, voltmeter and ammeter should be reduced to zero by adjusting the pointer when no current is passed.

(iv) A.C. instruments do not have uniformly spaced graduation, so reading should be taken carefully.

(v) There should be marked change in the impedance of the coil on introducing the soft iron core in the inductor. It should be ensured that core is completely inside the coil.

(vi) Pass the current through the coil only for very short interval to avoid change in resistance or impedance due to joules heating.

Activity 3

Object : To assemble a household circuit, comprising three bulbs, three (on / off) switches, a fuse and power source.

Apparatus : Three bulbs (20 W, 50 W & 100 W), three (On / Off) switches, flexible connecting wire with red and black plastic covering, a fuse wire, a two pin plug, main electric board with two pin socket and main switch.

Diagram :

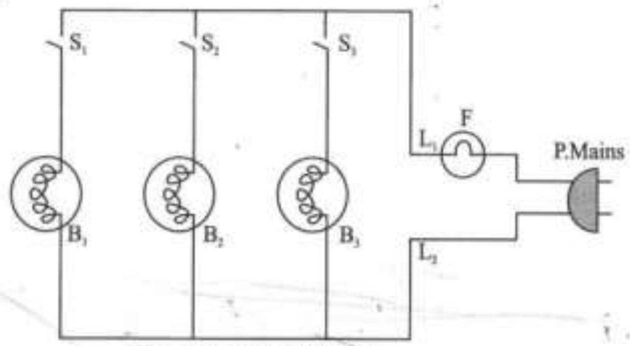


Fig. 3.1 : 3 bulb circuit

Theory : Household circuit functions on main suply 220 V, 50 Hz and current rattings of 5A for domestic supply for normal appliances, bulbs fluorescent tubes, fans etc.

Power supply : 15 A for heavy load appliances, refrigerator, air conditioner, geuser hot plates etc.

Total power consumption 'P' at any time,

$$P = P_1 + P_2 + P_3 + ...$$

where P_1, P_2, P_3 .... are powers drawn by appliances

At a potential 'V', the current I drawn from the mains is

$$P = VI \quad \text{i.e. } I = \frac{P}{V}$$

for P in watt and V in volt, I will be in amperes.

Normally, to protect the appliances from damage when unduly high currents are drawn, fuse of a little higher rating, 10 to 20% higher than the current normally drawn are connected in series with set of appliances.

Remember that in household circuits, all appliances are connected in PARALLEL with a switch connected in series with each appliance in supply LIVE line.

Also for further safety, a suitable value MAINS FUSE is connected in series with supply source. Note that fuse is a safety device, never use a fuse of much higher rating than the one recommended.

Procedure :

(i) Connect one end of the bulb holder to the red flexible wire through a switch S in series. Connect the other end of the bulb holder to the black flexible wire.

(ii) Connect the three bulb switch combination in parallel, red wire ends at one point and the black wire end at the other point.

(iii) Take two long flexible wires to serve as lead wire, one wire is red and the other is black.

(iv) Connect the red wire end to the red wire L_1. It will serve as a live lead.
(v) Connect the black wire ends to the black wire L_2. It will serve as neutral lead.
(vi) Put the fuse wire F in live lead L_1.
(vii) Connect a plug (two pin plug) P at the end of the two leads.,
(viii) Insert the plug in a two pin socket provided in the main electric board (inserting the upper pin for L_1 in upper hole of the socket and the lower ping for L_2 in lower hole of the socket).

Testing : Make the switches on one by one. Then put them off one by one.

Observation : The bulbs glow when the switch is made on. It stops glowing when the switch is put off.

Activity 4

Object : To assemble the components of a given electrical circuit (say Ohm's law circuit)

Apparatus : A voltmeter and an ammeter of appropriate range, a battery, a rheostat, one way key, an unknown resistance coil, connecting wires, a piece of sand paper.

Diagram :

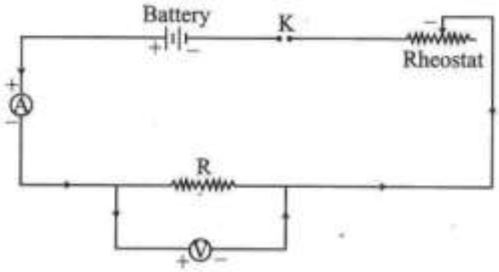


Fig. 4.1 : Circuit Diagram

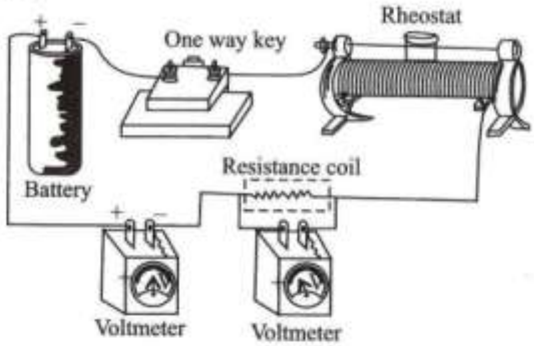


Fig. 4.2 : Arrangement Diagram

Procedure :
(i) Connect the items as shown in Fig. 4.2
(ii) For measuring current, ammeter should be connected in series with the components.
(iii) For measuring potential drop, voltmeter should be connected in parallel with the resistance coil or wire.

Conclusion : Assembly of all the components in electric circuit is complate.

Activity 5

Object : To study the variation in potential drop with length of a wire for a steady current.

Apparatus : A potentiometer, a battery, a rheostat, a voltmeter, a jockey, one way key, connecting wires.

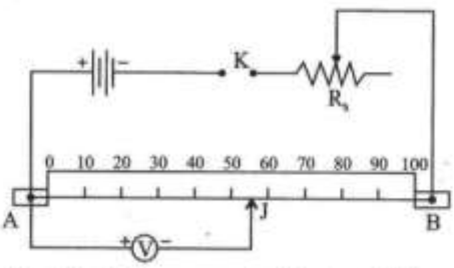


Fig. 5.1 : Measurement of potential drop

Theory : Potentiometer: It is an instrument which is used for the measurement of potential drop and e.m.f. of a cell.

Principle : If a steady current is maintaned by a battery E, through a wire of homogeneous composition and uniform area of cross-section, then the potential drop V along the wire is directly proportional to its length, i.e.,

$$V \propto I$$

or $$\frac{V}{I} = k \text{ (constant)}$$

Where k is the drop of potential per unit length. It is also called as the potential gradient.

Procedure (i) Arrange the circuit as shown in Fig. 5.1

(ii) Positive terminal of voltmeter is connected to positive end of the metre bridge wire. The negative end is connected to the jockey J.

(iii) The jockey is kept on the wire at 10 cm position. Note down the voltmeter reading.

(iv) The jockey is then kept at positions 20 cm, 30 cm, ... 90 cm, 100 cm and the corresponding voltmeter reading is taken.

(v) Record the observations.

Observation : (i) Range of voltmeter = ... V

(ii) Least count of voltmeter = ... V

(iii) Zero correction of Voltmeter V

(iv) Range of ammeter .... A

(v) Least count of ammeter scale .... A

(vi) Steady current shown by the ammeter = ... A

S. No.	Steady current I (A)	Wire length I (cm)	Potential drop for steably V(volt)	I Potential drop par cm $\frac{V}{l}$
1.		10		
2.		20		
3.		30		
4.		40		
5.		50		
6.		60		
7.		70		
8.		80		
9.		90		
10.		100		

Graph : A graph between V and l is plotted which is a straight line as shown in Fig. 5.2.

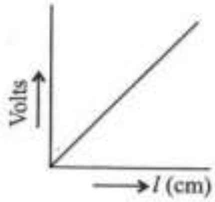


Fig. 5.2.

Conclusion : (i) The potential difference is directly proportional to the wire length when steady current passes through it.

(ii) The graph between V and l is a straight line.

Activity 6 :

Object : To draw a diagram of a given open circuit comprising of least a battery, resistor, rheostat, key, ammeter and voltmeter. Mark the components that are not connected in proper order and correct the circuit and also the circuit diagram.

Apparatus : A voltmeter and an ammeter of appropriate range, a battery, a rheostat, one way key, unknown resistance wire or resistance coil, connecting wires, a piece of sand paper

Diagram : An open circuit (not connected circuit) is given:

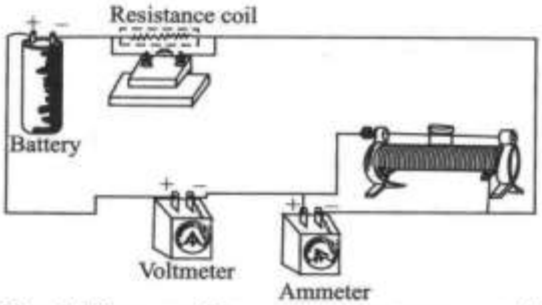


Fig. 6.1 : Open Circuit Diagram (Components not connected in proper order).

Theory : (a) **Functional electrical circuit:** A circuit is functional only when all the components of the circuit are connected in proper order, assuming that all circuit components are in working condition and key is closed.

(b) **Open electrical circuit :** An open circuit means that there is a break in some part of the circuit. The break may be deliberate suchas key is in open position or three is a fault such as broken wire or burnt or loose connection.

Procedure :
(1) Draw the circuit 6.1 in copy.
(2) Write various components & mark those which are not connected in proper order.
(3) Draw the correct circuit diagram.
(4) Now close the key and check up whether the corrected circuit is now functional.

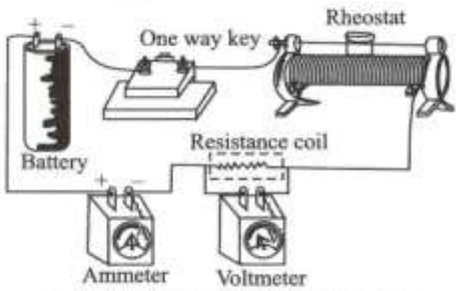


Fig. 6.2 : Arrangement Diagram

Result : The connected circuit assembled using components in proper order is found functional on checking.

Precautions :
(1) Range of Voltmeter and Ammeter should be chosen.
(2) Before making connections, the ends of the connecting wires should be cleaned by rubbing with (sand paper).

ACTIVITIES

Section - B

Activity 8

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

Apparatus : Multimeter, Battery, eliminator, reversing key, above mixed collection of items.

Diagram :

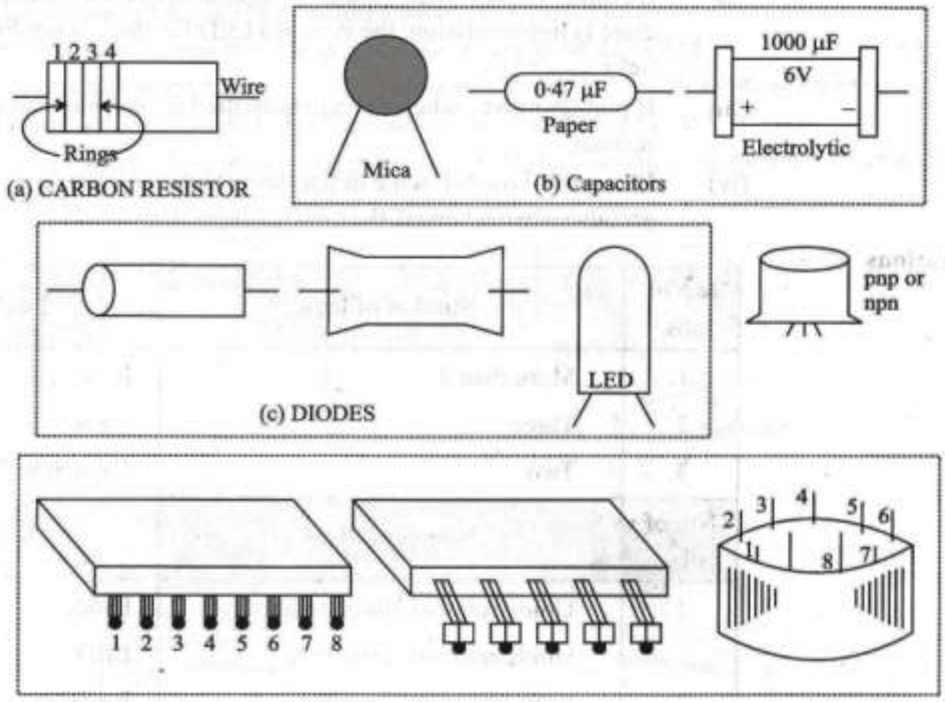


Fig. 8.1 : Some of the commonly available electronic components.

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

(i) 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.

(ii) 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.

(iii) A transistor is a three terminal device. The terminals represent emitter (E), base (B) and collector (C)

(iv) An IC (integrated circuit) is a multi terminal device in form of a clip.

(v) A resistor is a two terminal device. It conducts when either forward biased or reverse biased (In fact there is no forward or reverse bias for a resistor). It conducts even when operated with A.C. voltage.

(vi) A capacitor is also a two terminal device. It does not conduct when either forward biased or reverse biased (Hence it does not conduct with D.C. voltage) However it conducts with A.C. voltage.

Procedure : (i) If the item has four or more terminals and has from of a chip, it is an IC (Integrated circuit).

(ii) If the item has three terminals, it is transistor.

(iii) If the item has two terminals, it may be diode, a LED, a resistor or a capacitor.

To differentiate proceed as ahead :

Make a series circuit with battery eliminator, reversing key, the item and the multimeter with range set in milliamperes. Switch on the battery eliminator and watch the movement of the multimeter pointer.

(i) If pointer moves when voltage is applied in one way and does not move when reversed and there is no light emission, the item is diode i.e. there is only unidirectional flow of curent and emits no light.

Activity 10

Object : To observe refraction and lateral deviation of a beam of light incident obliquely on a glass slab.

Apparatus : Glass slab, drawing board, white paper sheet, drawing pins, office pins, protractor.

Diagram :

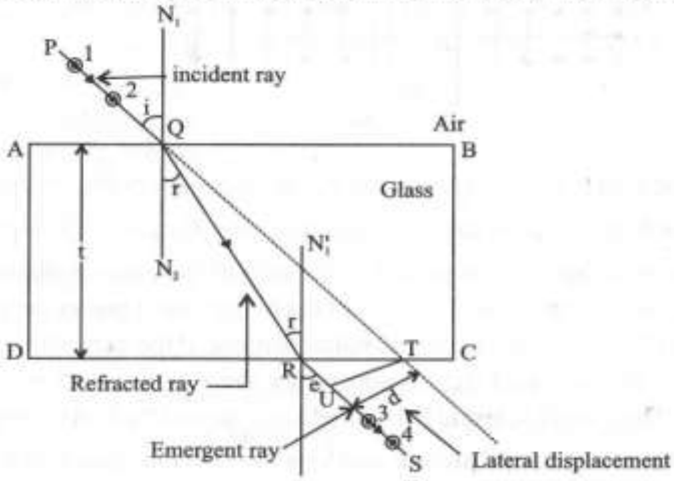


Fig. 10.1 : Refraction through a glass slab.

Theory : When a ray of light becomes incident on a parallel faced glass slab, it emerges from it in same direction as the incident ray. It only suffers a lateral displacement proportional to the slab thickness (t). The lateral displacement is given by $d = t \sec r \sin(i - r)$.

Procedure :

(i) Fix a white paper sheet by drawing pins on a drawing board.

(ii) Take a glass slab and put it symmetrically in the middle of the paper and mark its boundary ABCD.

(iii) Draw a normal at point Q on face AB and draw a line PQ making an angle i with the normal. PQ will represent an incident ray.

(iv) Fix two pins at points 1 and 2 on the line PQ at distances 8 cm or more between themselves.

(v) See images of these pins through face DC and fix two more pins at point 3 ad 4 (8 cm or more apart) such that these two pins cover the images of first two pins, all being along a straight line.

(vi) Remove the glass slab. Draw straight line RS through points 3 and 4 to represent emergent ray. Join QR to represent refracted ray.

(vii) Draw normal at point R on face DC and measure angle e. It comes to be equal to angle i. Produce PQ forward to cut DC at T. Draw TU perpendicular to RS. TU measure lateral displacement d.

The ray of light emerging from a glass slab is parallel to the incident light and it is laterally displaced.

Activity 12

Object : To observe diffraction of light due to a thin slit between sharp edges of razor blades.

Apparatus : Microscope slides (two), two razor blades, adhesive tapes, a screen and source of monochromatic light (laser pencil), black paper.

Theory : When light is allowed to pass through fine openings or around sharp obstacles like edge of razor blades such that size of opening or sharpness of edges is of the order of wavelength of light, it bends around corners. Bending of light around sharp obstacles or corners is termed as diffraction. The angle of diffraction for different orders (n) of diffraction is given as

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

Diagram :

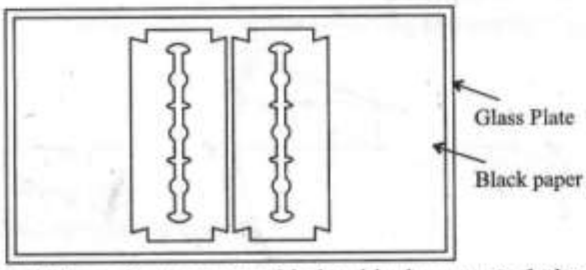


Fig. 12.1A thin slit made by using two razor blades, black paper and glass plate.

Procedure :

(i) Making of fine slit using razor blades.

(ii) Place two razor blades with their sharp edges facing each other and extremely close to each other such that there is small gap of the order of fraction of millimeter. Fig. 12.1

(iii) Paste the blades using cello-tape leaving no gap between paper and glass plate.

(iv) Cut the small slit in between the sharp edges of blades.

(v) Place the slit about 0.5 m from a wall and a source of light with a slit in front of it at a distance of about 20 cm from the slit.

(vi) Observe the light falling on the wall.

(vii) It will be observed that instead of having a bright slit like light on the wall, the light spreads and on either side of slit secondary maxima i.e. slits with lower intensity are seen.

Conclusion : When light waves are made to be incident on very fine openings (slit) they bend and spread showing the phenomena of diffraction of light.

Precautions :

(i) Black paper should be pasted such that there is no air gap between the glass plate and paper.

(ii) The slit should be made as thin as possible.

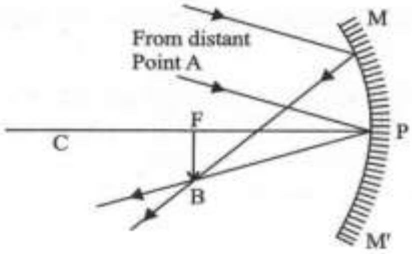
(iii) Instead of using ordinary electric bulb light, laser torch light will give better effect on the screen.

Activity 13 (a)

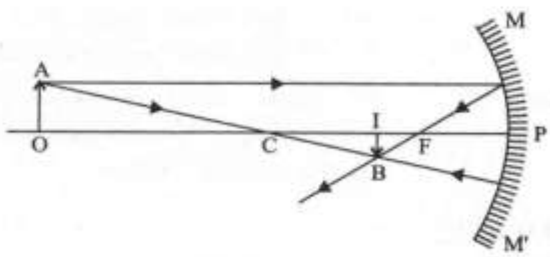
Object : To study the nature and size of the image formed by concave mirror using candle and a screen (for different distances of the candle form the mirror)

Apparatus : An optical bench with three uprights, a concave mirror with holder, a burning candle, a card board screen.

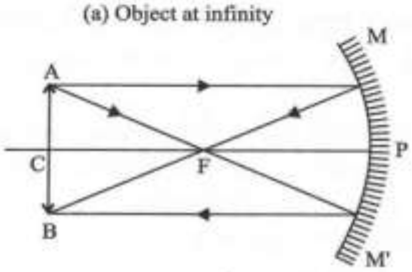
Diagram :



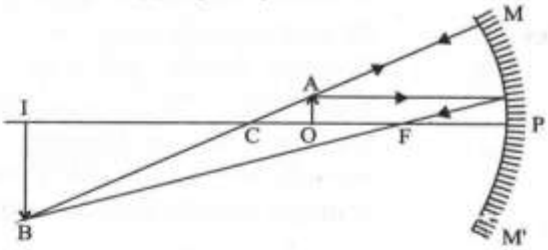
(a) Object at infinity



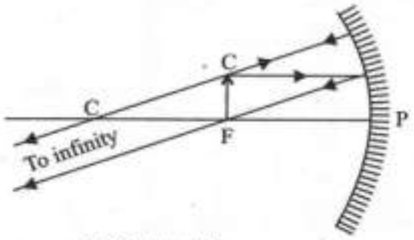
(b) Object beyond C



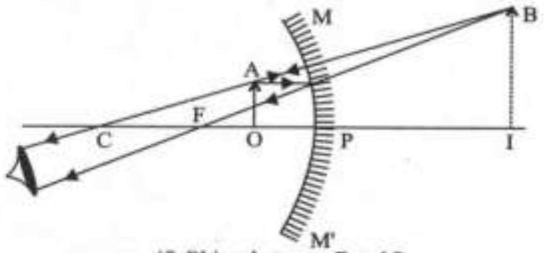
(c) Object at C



(d) Object between C and F



(e) Object at F



(f) Object between F and P

Fig. 13.1 (a) : Focal length of a concave mirror

Theory : The position, nature and the relative size of the image of an object formed by a concave mirror depends upon the position of the object with respect to the pole of the mirror.

Procedure :

(i) Find rough focal length of the concave mirror by usual method.

(ii) Mount the concave mirror in holder in first upright and keep it near one end of the optical bench, keeping mirror face inward.

(iii) Mount the card board screen on a second upright and keep it at distance equal to rough focal length of mirror, from first upright.

(iv) Mount the burning candle in third upright and keep it near other end of the optical bench.

(v) Adjust heights so that the inverted image of erect flame of burning candle is formed on screen. Move the screen to make the image sharp. The screen will be nearly at the focus of the concave mirror.

(vi) The image will be real, inverted and much more diminished.

(vii) As the burning candle is moved towards the mirror, the screen has to be moved away from it for getting a sharp flame image. The inverted image size increases.

(viii) When the position of the candle approaches centre of curvature of the mirror, the screen also approaches the same position. The image size will be equal to the actual flame size.

(ix) Now interchange the upright. Bring candle upright nearer to mirror than the screen upright.

(x) Move the candle further nearer the screen has to be moved away for getting an enlarged inverted real image on screen.

(xi) As the candle reaches the focus of the mirror, the screen may not be able to get its image which will be formed at infinity i.e. beyond the length of optical bench.

S. No.	Position of		Nature of Image		
	Object	Image	Real of Inverted	Erect or inverted	Magnified or diminished
1.	Art Infinity	At F	Real	Inverted	Point Image of highly diminished
2.	Beyond C	Between F and C	"	"	Diminished
3.	At C	At C	"	"	Same Size
4.	Between F and C	Beyond C	"	"	Magnified
5.	At F	At infinity	"	"	Magnified but blurred
6.	Within F	Behind the mirror	Virtual	Erect	Highly magnified

Conclusion : This change in position, nature and size of the image is according to theoretical prediction.

Activity 13(b)

Object : To study the nature and size of the image formed by a convex lens using candle and a screen for different distances of the candle from the lens.

Apparatus : An optical bench with three uprights, a convex lens with holder, a burning candle, a card board screen.

Diagram :

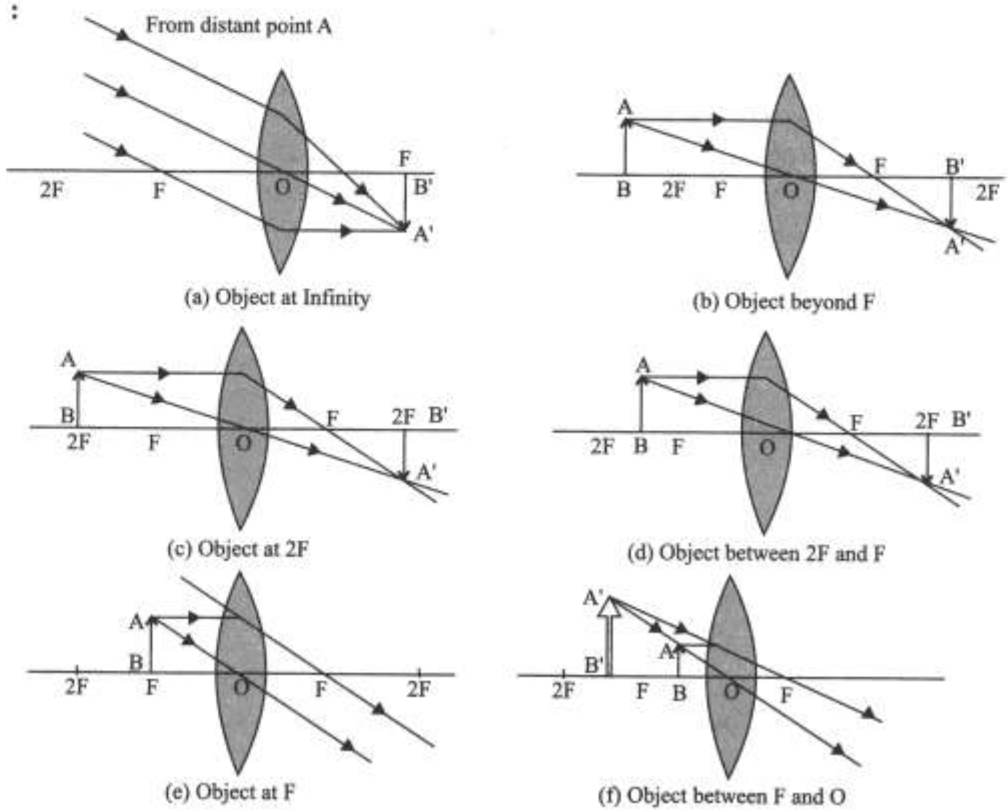


Fig. 13.1 (b) Ray diagrams for image formation for various positions of object.

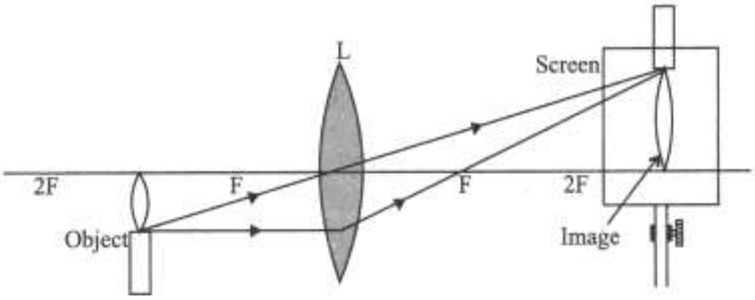


Fig. 13.2 (b) Candle and screen method for observing the size of image.

: The size of the image of an object formed by a convex lens depends upon the position of the object with respect to the lens. The same has been shown by the ray diagrams in Fig. 13.1 (b).,

: (i) Find rough focal length of the convex lens by usual method.

(ii) Mount the convex lens holder in central upright and keep it in the middle of the optical bench.

(iii) Mount the card board screen on another upright and keep it at distance equal to rough focal length of the lens, from the central upright.

(iv) Mount the burning candle in third upright and keep it on the other side of the central upright and near the end of the optical bench.

(v) Adjust heights so that the inverted image of erect flame of burning candle is formed on screen. Move the screen to make the image sharp. The screen will be nearly at the focus of the convex lens.

(vi) The image will be real inverted and much more diminished.

(vii) As the burning candle is moved towards the lens on one side, for getting sharp, for getting sharp flame image. The inverted image size increases.

(viii) When the position of the candle is at distance 2f from the lens, the screen is also at same distance on the other side. The image size will be equal to the actual flame size.

(ix) Move the candle further nearer to the lens. The screen has to be moved away for getting an enlarged inverted real image on screen.

(x) As the candle reaches the focus of the lens, the screen may not be able to get its image which will be at infinity i.e. beyond the ends of the optical bench.

: Rough focal length of the convex lens, f = ... cm

Size of the candle flame = ... cm

S. No.	Position of lens (cm)	Position of candle flame relative to the lens (cm)	Position of the image (cm)	Size of the image	
				in (cm)	relative to object
1.	....	At infinity	....	....	diminished
2.	....	Beyond 2F	....	....	diminished
3.	....	At 2F	....	....	equal
4.	....	Between f and 2F	....	....	magnified

: This change in position, nature and size of the image is according to theoretical predictions.

ACTIVITY 14

To obtain a lens combination with specified focal length by caring two lenses from the given set of lenses.

No particular apparatus is used.

A set of thin convex lenses lens holder with stand, A white painted vertical wooden board with board stand mails scale.

Theory :

1. With a convex lens, the real image of distance object is formed at a distance equal to its focal length. Reciprocal of focal length in metre is called power of lens. Power of lens is expressed in diopter.
2. If f_1 and f_2 be the focal lengths of the two lenses and F be the focal length of the two lenses and F be the focal length of the combination.

   Then

   For lenses of power P_1 and P_2 and combination of power P

   Then $P = P_1 + P_2$

Procedure :

1. Set the lens L_1 of focal length f in lens upright

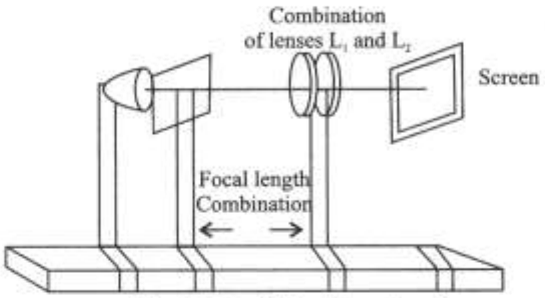


Fig. Study of focal length of combination of lenses

2. Obtain the image of (brightly) illuminated distance object wire gange on the screen.
3. Measure the distance between the lens and screen upright when two bright and distance image is focused

   Record its focal length as f_1 =
4. Similarly replace first levis by second length and measured its focal length f_2 =
5. Now bring the two lenses L_1 and L_2 in contact.
6. Obtain the distinct image (using combined lenses) of a well illuminated distance object on the screen and measured its focal length.
7. Within experimental error find the difference in the calculated focal length & measured focal length.

Calculation observed combined focal length

Conclusion

From a given set of two lenses, the combined lens of specified focal length can be obtained by using the relation. P combination $= P_1 + P_2$ [Algebric sum of P_1 and P_2.

Precaution

1. Thin lenses should be taken.
2. Lenses should have save aperture.