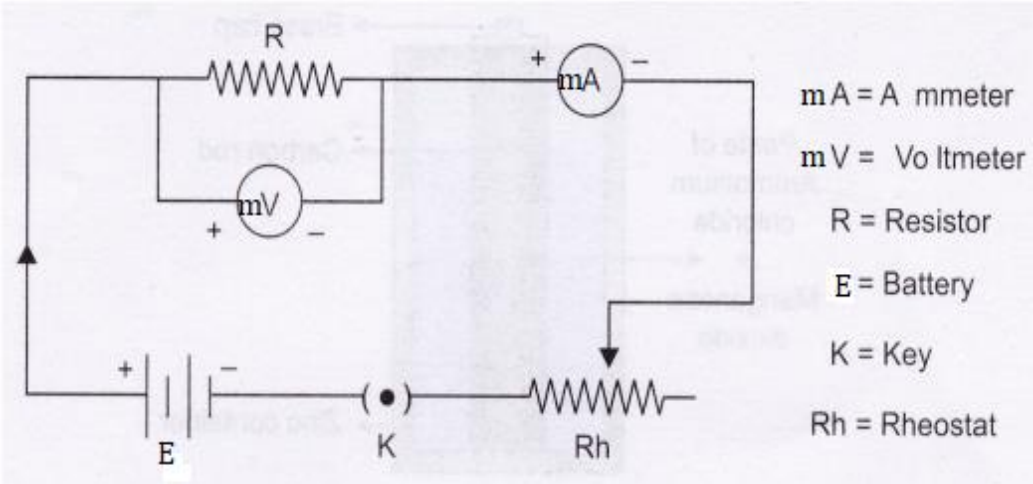
EXPERIMENT 1

OHMS LAW

AIM: To determine resistivity of two / three wires by plotting a graph for potential difference versus current.

APPARATUS: Resistance wires, cell, key. Rheostat, ammeter, voltmeter etc

CIRCUIT:



THEORY:

According to Ohm's law, the potential difference across the ends of a conducting wire is directly proportional to the current flowing through it.

$$V \propto I$$

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

The resistivity / specific resistance of a wire of length L and radius r is given by:

$$\rho = \frac{R\,\pi r^2}{L}$$

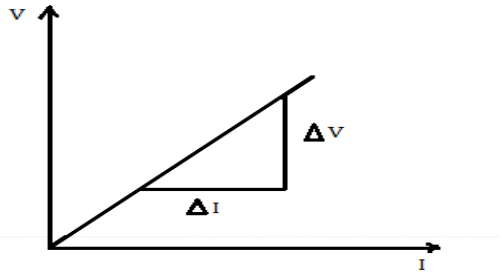
PROCEDURE

The battery (E), resistance wire (R), rheostat (Rh), ammeter (A), voltmeter (V) and key (K) are connected as shown in the figure. The key is closed and the current through the rheostat is adjusted to read a suitable current. The corresponding voltmeter (V) is noted. The ratio V/I=R is calculated. The experiment is repeated

for different values of currents by adjusting the rheostat. In each case, the ration V/I are calculated and mean value of R is found.

A graph is plotted by taking current (I) along the X-axis and voltage (V) along the Y-axis. It is a straight line. Resistance of the wire is found out by calculating the slope of the graph. The area of the wire (A) and the length of the wire (L) are also measured. The resistivity / specific resistance of the material of the wire is calculated using the formula, $\rho = \frac{RA}{L}$

NATURE OF GRAPH:



From the graph, resistance is given by:

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

OBSERVATIONS:

WIRE 1

Length of the wire L_1= ---------- cm=---------- m

Area of cross section of the wire A_1= ---------- mm^2 = ---------- m^2

WIRE 2

Length of the wire L_2= ---------- cm=---------- m

Area of cross section of the wire A_2 = ---------- mm^2 = ---------- m^2

Resistances of the wires

Least count of the ammeter=---------- mA

Least count of voltmeter = ---------- mV

	NO	AMMETER READING (mA)	VOLTMETER READING (mV)	RESISTANCE R= V/I (Ω)	MEAN RESISTANCE (Ω)
WIRE 1	1 2 3 4 5				R_1=----------
WIRE 2	1 2 3 4 5				R_2=----------

CALCULATIONS

1. RESISTIITY OF WIRE 1

$$\rho_1 = \frac{R_1 A_1}{L_1} = - - - - - - - - - - - - - - - - - \Omega m$$

2. RESISTIVITY OF WIRE 2

$$\rho_2 = \frac{R_2 A_2}{L_2} = - - - - - - - - - - - - - - - - - \Omega m$$

RESULT:

The resistivity of the given wires :

ρ_1=---------- Ωm

ρ_2=----------Ωm

PRECAUTIONS:

1. Connections must be neat clean and tight.
2. A low resistance rheostat must be used.

3. Thick copper wires should be used for the connections.
4. Ammeter and voltmeter should be of proper range.

SOURCES OF ERROR

1. Temperature of the resistance wire might have changed.
2. Parallax error
3. The instrument screws may be loose

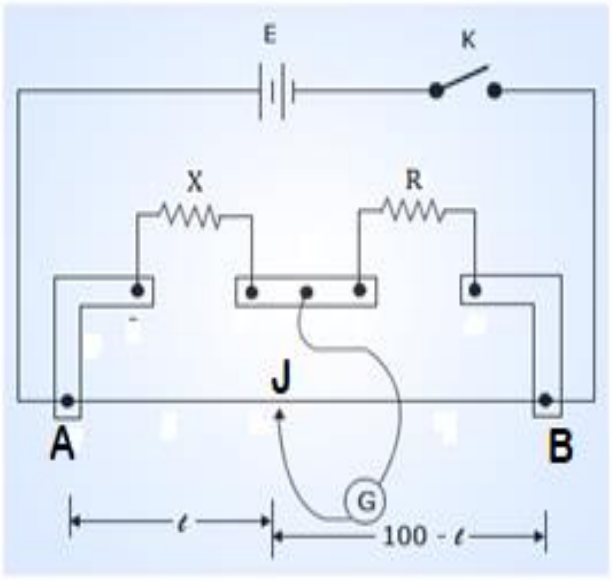
EXPERIMENT 2

METER BRIDGE-I

AIM: To find resistance of a given wire / standard resistor using a metre bridge.

APPARATUS: Meter bridge, resistance wire, key, resistance box, jokey, connection wires, battery etc.

CIRCUIT:



X - unknown resistance
R - Resistance box
l - balancing lence
E - battery
K - key
G - galvanometer

THEORY:

If X is the unknown resistance connected in the left gap , R is the known resistance in the right gap and if *l* is the balancing length then the unknown resistance X is given by:

$$X = \frac{Rl}{(100 - l)}$$

PROCEDURE

Arrange the apparatus as shown in the diagram. Connect the resistance wire X whose resistance is to be determined in the left gap and connect the resistance box R in the right gap. Take out a suitable resistance from the resistance box, plug the key K. Touch the jokey gently first at left end and then at right end of the bridge wire. Note the deflection in the galvanometer. If the galvanometer shows deflections in opposite directions, the connections are correct. Slide the jokey gently along the wire from left to right till galvanometer gives zero deflection. The point where the jokey is touching the wire is null point. Measure the balancing length AJ= *l* Take at least five sets of observations in the same way by changing the values of R in steps. Record your observations.

Calculate the resistance of the resistance wire using the equation $X = \frac{R\,l}{(100-l)}$

OBSERVATIONS:

NO	KNOWN RESISTANCE FROM RESISTANCE BOX (R)	BALANCINNG LENGTH *(l)*	(100-*l*)	UNKNOWN RESISTANCE (X) $X = \frac{Rl}{(100 - l)}$
	Ω	cm	cm	Ω
1. 2. 3. 4. 5.				

Mean resistance X =----------Ω

RESULT:

Resistance of the given wire = ----------Ω

PRECAUTIONS:

1. Connections must be neat clean and tight.

2. Hold the jokey perpendicular to the wire of the meter bridge.

SOURCES OF ERROR:

1. Keys in the resistance box may be loose.

2. Parallax error.

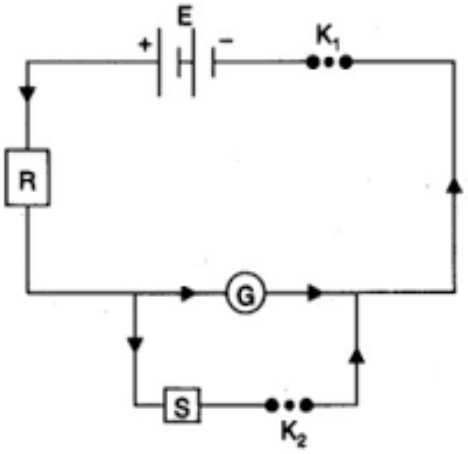
EXPERIMENT-3

GALVANOMETER: HALF DEFLECTION METHOD

AIM: To determine the resistance of a galvanometer by half deflection method and to find its figure of merit.

APPARATUS: Galvanometer, resistance boxes, battery eliminator, key, etc

CIRCUIT:



E- battery eliminator
K1 & K2- one way keys
R- High resistance box (10,000 ohm)
G- galvanometer
S-shunt resistance box(100 ohm)

THEORY:

The resistance of the given galvanometer as found by half deflection method is given by:

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

Where R is the resistance connected in series with the galvanometer and S is the shunt resistance

The figure of merit of the galvanometer

$$k = \frac{E}{(R+G)\theta}$$

Where E is the emf of the cell and Θ is the deflection produced with resistance R

PROCEDURE:

Make the connections as shown in the circuit diagram. Take out a high resistance (say 5000 Ω) from the resistance box R and insert the key K1 only. Adjust the value of R so that the deflection is maximum, even in number and within the scale. Note the deflection in the galvanometer. Insert the key K2 also and without changing the value of R, adjust the value of shunt S, such that the deflection in the galvanometer reduces to exactly half of the initial value. Note the value of resistance S. Repeat the experiment for different values of R.

With each set of observations calculate the Resistance of the galvanometer (G) and the figure of merit of the galvanometer (k). Calculate the mean values of G and k.

OBSERVATIONS

E=---------- V

NO	**RESISTANCE** **R**	**DEFLECTION OF GALVANOMETER** **Θ**	**SHUNT RESISTANCE** **S**	**HALF DEFLECTION** **Θ/2**	**GALVANOMETER RESISTANCE** $G = \frac{RS}{R-S}$	**FIGURE OF MERIT** $k = \frac{E}{(R+G)\theta}$
	Ω		**Ω**		**Ω**	**Amp/divisions**
1 2 3 4 5						

Mean value of the galvanometer resistance, G=----------Ω

Mean value of the figure of merit, k=---------- A/division

RESULT

The resistance of the given galvanometer, G=----------Ω

The figure of merit of the galvanometer, k=---------- A/division

PRECAUTIONS

1. Connections must be neat, clean and tight.

2. All the keys in the resistance boxes should be tight.

SOURCES OF ERROR

1. The instrument screws may be loose.

2. Parallax error.

EXPERIMENT-4

CONVERSION OF GALVANOMETER INTO VOLTMETER

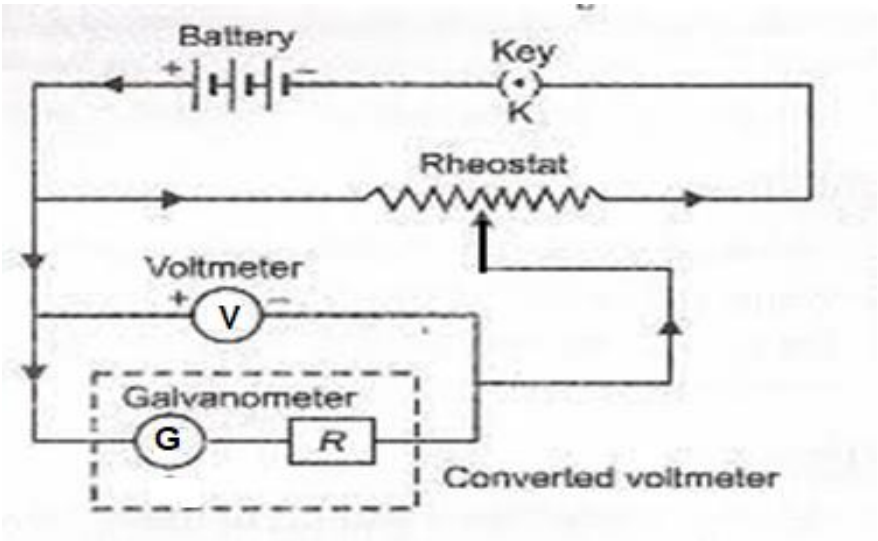
AIM:

To convert the given galvanometer of known resistance and figure of merit into a voltmeter of desired range and to verify the same.

APPARATUS:

A galvanometer, a voltmeter, 0-2V, a battery eliminator, resistance box, one way key, a rheostat, connecting wires and a piece of sand paper.

CIRCUIT DIAGRAM:



THEORY:

A galvanometer can be converted into a voltmeter of desired range by connecting a suitable high resistance in series with the galvanometer.

If G is the galvanometer resistance, V is the range of conversion and Ig is the current required for the full scale deflection of the galvanometer, the series resistance required for the conversion is:

$$R = \frac{V}{I_g} - G$$

PROCEDURE:

Calculate the value of the series resistance R to be connected in series with the galvanometer for a given range V. Connect a resistance box in series with the galvanometer. Take out the plug of resistance R from the resistance box. Make the connections as shown in the circuit diagram. Insert the key K and adjust the movable contact of the rheostat and note down the readings of voltmeter and galvanometer. Calculate the converted voltmeter reading by multiplying the deflection of galvanometer by the least count of the galvanometer converted to voltmeter. Find the difference between the standard voltmeter reading and the converted voltmeter reading. The difference give the error in the conversion.

Move the variable contact of the rheostat and take at least five observations covering the whole range of the voltmeter.

CALCULATIONS FOR THE SERIES RESISTANCE REQUIRED FOR CONVERSION:

Resistance of the galvanometer, G=---------- ohm

The figure of merit of the galvanometer, k=---------- amp/devision

Number of divisions in the galvanometer scale, n=----------

Current for full scale deflection, Ig =---------- A

Range of conversion, V=---------- V

Resistance to be placed in series with the galvanometer,

$$R = \frac{V}{I_g} - G = - - - - - - - - - - - - - - - - - - - \ ohm$$

TABLE FOR VERIFICATION:

Least count of the converted voltmeter, L.C = $\frac{V}{n} = - - - - - - - - - V$

S. NO	Reading of converted voltmeter		Standard voltmeter reading (V_2) volt	Error V_2-V_1 volts
	Deflection (Θ)	Potential difference V_1=Θ x L.C volt		
1 2 3				

RESULT:

The value of the actual and measured value of the potential difference is very small and conversion is perfect.

PRECAUTIONS:

1. All the connections should be neat, clean and tight
2. The emf of the battery should be constant

SOURCES OF ERROR

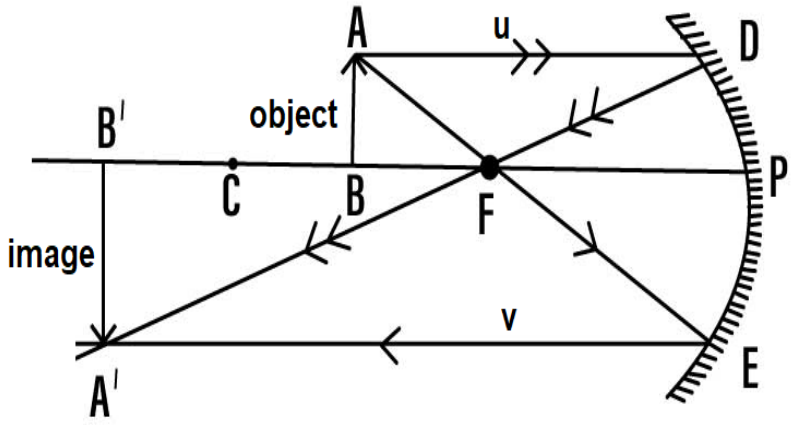
1. The keys in the resistance box may be loose.
2. Parallax error.

EXPERIMENT 5:
CONCAVE MIRROR

AIM: To find the focal length of the given concave mirror by plotting graph between u and v.

APPARATUS: Concave mirror, screen, illuminated wire gauze, stand, meter scale etc.

RAY DIAGRAM:



THEORY:

By u-v method, the focal length of a mirror is given by:

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

Where, u is the distance of the object from the mirror and v is the distance of the image from the mirror. In concave mirror, for real image, u and v are positive.

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

PROCEDURE:

The concave mirror is mounted on a stand and is placed in front of an illuminated wire gauze. The screen is placed on the same side of the mirror. The screen alone is adjusted to obtain a well-defined image of the wire gauze on it. The distance of the object and the image from the mirror are measured as u and v. the focal length is then calculated using the formula,

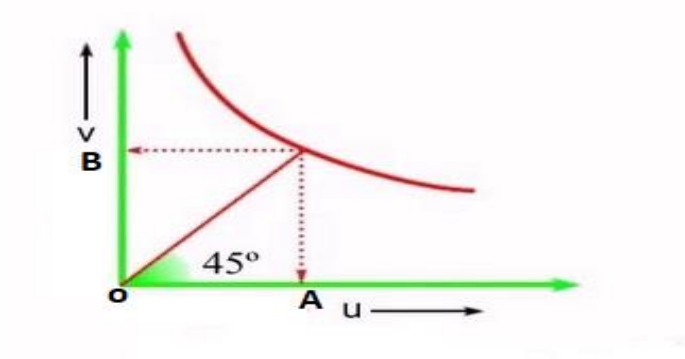
$$f = \frac{uv}{u+v}$$

The experiment is repeated for different values of u and the mean value of the focal length is found.

A graph is drawn with u along the X axis and V along the Y-axis, taking a common origin and same scale for both u and v. The bisector of the angle XOY is drawn, meeting the curve at C. Draw BC parallel to X axis and AC parallel to Y-axis. OA and OB are measured. Now OA=OB=2f

$$\therefore f = \frac{OA + OB}{4}$$

NATURE OF u-v GRAPH



Focal length from u-v graph:

$$f = \frac{OA + OB}{4}$$

OBSERVATIONS AND CALCULATIONS:

NO:	Distance of the object from mirror u	Distance of the image from mirror V	Focal length $f = \frac{uv}{u+v}$
	Cm	Cm	Cm
1. 2. 3. 4. 5. 6.			

Mean focal length, f=---------- cm

RESULT:

The focal length of the convex lens

i) By u-v method, f=---------- cm
ii) From u-v graph, f=---------- cm

PRECAUTIONS:

1. The image should be sharp
2. Mirror must be clean

SOURCES OF ERROR:

1. The principal axis of the mirror may not be parallel to the plane of the table.
2. Parallax error.

EXPERIMENT 6:
CONVEX MIRROR

AIM:

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

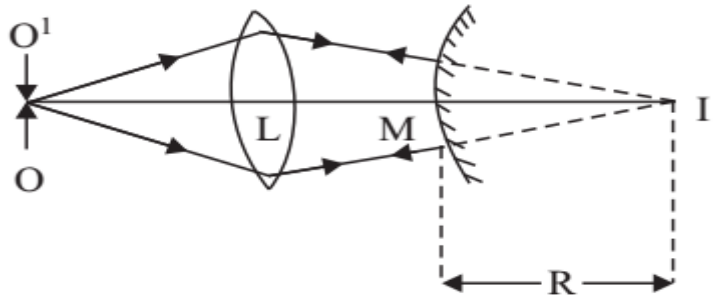
APPARATUS:

A convex mirror, convex lens, screen, stand, illuminated object, scale

PRINCIPLE:

When a light ray incident normally on a convex mirror, after reflection, the ray retraces the path. Thus image is obtained side by side with the object. Then the radius of curvature of the mirror is the distance between the mirror and the screen.
Now, focal length of the mirror, f= R/2

RAY DIAGRAM:



PROCEDURE:

The convex lens is mounted on a stand in front of an illuminated wire gauze. The screen is placed on the other side of the lens. The position of the screen is adjusted to obtain a well-defined sharp image of the wire gauze on the screen. Now the convex mirror is placed between the lens and the screen with its reflecting surface facing towards the lens. The position of the mirror is adjusted so as to get the image of the object side by side with it. The distance between the mirror and the screen is measured. This gives the radius of curvature (R) of the mirror. The experiment is repeated by changing the distance between the object and the lens. Each time focal length of the mirror is calculated using the formula, f= R/2.

OBSERVATIONS:

Trial No	Distance between screen and mirror R	Focal length of the mirror F= R/2
	Cm	cm
1. 2. 3. 4. 5.		

The mean focal length of the mirror is. f=----------

RESULT:

The focal length of the given convex mirror = ----------

PRECAUTIONS:

1. The image formed should be sharp
2. The lens and the mirror should be clean
3.

SOURCES OF ERROR:

1. The lens and mirror may not be placed co-axially
2. Parallax error.

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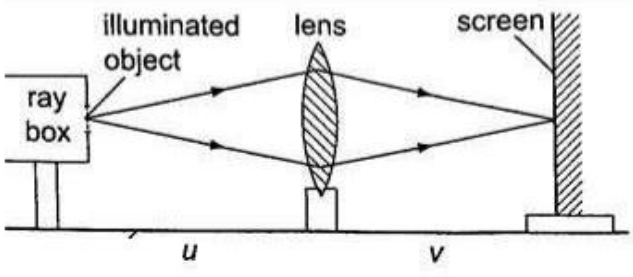
EXPERIMENT 7: CONVEX LENS

AIM: To find the focal length of the given convex lens by plotting graph between u and v.

APPARATUS: Convex lens, screen, illuminated wire gauze, stand, meter scale etc.

RAY DIAGRAM:



THEORY:

By u-v method, the focal length of a lens is given by:

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

Where, u is the distance of the object from the lens and v is the distance of the image from the lens. In convex lens, for real image, u is negative and v is positive.

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

PROCEDURE:

The convex lens is mounted on a stand and is placed in front of an illuminated wire gauze. The screen is placed on the other side of the lens. The screen alone is adjusted to obtain a well-defined image of the wire gauze on it. The distance of the object and the image from the lens are measured as u and v. the focal length is then calculated using the formula,

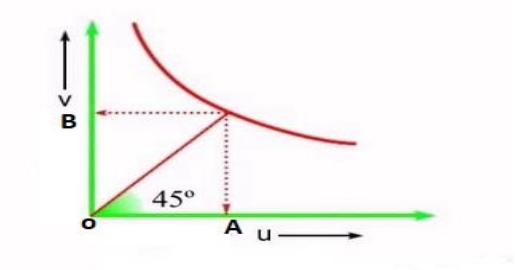
$$f = \frac{uv}{u+v}$$

The experiment is repeated for different values of u and the mean value of the focal length is found.

A graph is drawn with u along the X axis and V along the Y-axis, taking a common origin and same scale for both u and v. The bisector of the angle XOY is drawn, meeting the curve at C. Draw BC parallel to X axis and AC parallel to Y-axis. OA and OB are measured. Now OA=OB=2f

$$\therefore f = \frac{OA + OB}{4}$$

NATURE OF u-v GRAPH



Focal length from u-v graph:

$$f = \frac{OA + OB}{4}$$

OBSERVATIONS AND CALCULATIONS:

NO:	Distance of the object from lens U	Distance of the image from lens V	Focal length $f = \frac{uv}{u+v}$
	Cm	cm	cm
1. 2. 3. 4. 5. 6.			

Mean focal length, f=---------- cm

RESULT:

The focal length of the convex lens

iii) By u-v method, f=---------- cm
iv) From u-v graph, f=---------- cm

PRECAUTIONS:

1. The image should be sharp
2. Lens must be clean

SOURCES OF ERROR:

1. The principal axis of the lens may not be parallel to the plane of the table.
2. Parallax error.

EXPERIMENT 8:
CONCAVE LENS

AIM: To determine the focal length of the given concave lens using convex lens.

APPARATUS: convex lens, concave lens, lens stand, meter scale etc

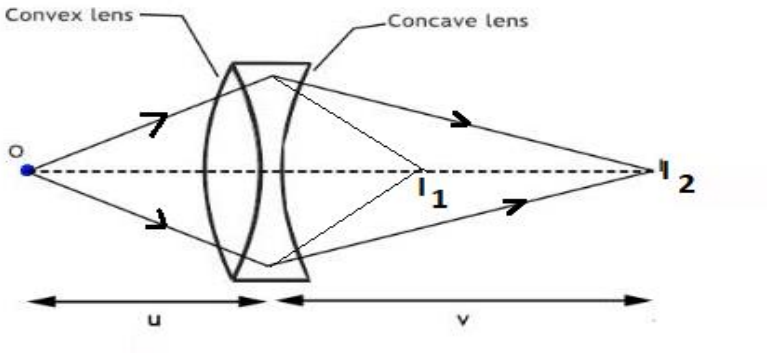
THEORY:

When a convex lens of focal length (f1) and a concave lens of focal length (f2) are placed coaxially in contact with each other, the equivalent focal length (F) of the combination is given by:

$$\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2}$$

$$f_2 = \frac{f f_1}{f_1 - f}$$

RAY DIAGRAM:



I_1 is the image formed by convex lens I_2 is the image formed by the combination of the convex lens and the concave lens.

PROCEDURE

1. The focal length of the given convex lens (f1) is determined by u-v method. The convex lens is mounted on a stand and is placed in front of an illuminated wire gauze. The screen is placed on the other side of the lens. The screen alone is adjusted to obtain a well-defined image of the wire gauze on it. The distance of the object and the image from the lens are measured as u and v. the focal length is then calculated using the formula,

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

   The experiment is repeated for different values of u and the mean value of the focal length is found.

2. The given concave lens is then kept in contact with the convex lens. The focal length of the combination (F) is also determined by u-v method. (repeat steps in 1 with the combination of convex lens and concave lens)
3. Now the focal length (f2) of the concave lens can be calculated as:

   $$f_2 = \frac{f f_1}{f_1 - f}$$

OBSERVATIONS AND CALCULATIONS:

LENS USED	NO:	Distance between object and lens (u)	Distance between image and lens (v)	Focal length $f_2 = \frac{ff_1}{f_1 - f}$	Mean focal length
		(cm)	(cm)	(cm)	(cm)
CONVEX LENS	1 2 3	20 25 30			$f_1 = - - -$
COMBINATION OF CONVEX LENS AND CONCAVE LENS	1 2 3	30 35 40			$F = - - -$

Focal length of the concave lens:

$$f_2 = \frac{ff_1}{f_1 - f} = - - - - - - - - - - - cm$$

RESULT:

The focal length of the concave lens=---------- cm

PRECAUTIONS:

1. The image should be sharp
2. The lenses should be clean

SOURCES OF ERROR:

1. The lenses may not be placed co-axially
2. Parallax error.

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