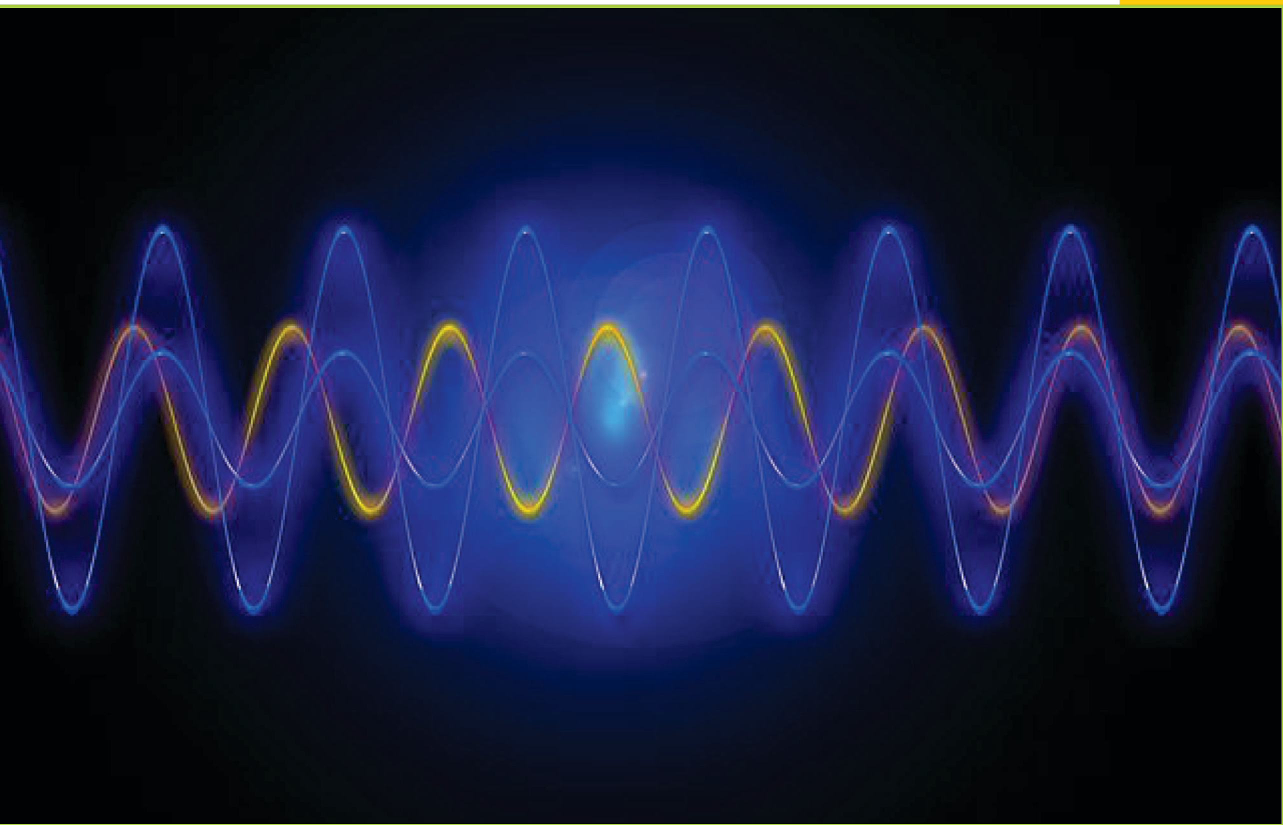
Comprehensive

ICSE

LAB MANUAL PHYSICS



CLASS X

Certificate

Certified that this is the bonafide work of ______________________________
(Student's Name)

of __________ of ____
(Class/Section) (School's Name)

He/She has performed these experiments during the academic year __________

Number of practicals certified ______________ out of ____________ in

____
(Subject's Name)

- The student's initiative, cooperation and participation during the practical classes was Excellent/ Good/ Average/ Below Average.
- His/Her aesthetic presentation, visual appeal, expression and neatness is Excellent/ Good/ Average/ Below Average.
- His/Her content accuracy, creativity, originality and analysis of different perception is Excellent/ Good/ Average/ Below Average.

______________	______________	______________
Examiner's Signature	Principal's Signature (with school's seal)	Teacher's Signature

Comprehensive

LAB MANUAL PHYSICS

CLASS X

(*For ICSE Board*)

By

Bindu Sharma

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PREFACE

Dear students,

In this age of nail-biting competition, it really helps to be well equipped in subject knowledge in order to break the ice in the competitive area. So, while the market is flooded with numerable repetitions of book which mars your intellectuality and competency. We have endeavoured to reach out to your widen examination needs in this edition. Keeping in mind the broader comprehensive needs of subject knowledge we have put in our best efforts in this book.

Science is learnt best by doing. We can understand the principles of science by doing experiments. Therefore, the practical work in laboratory is an essential part of the student's life. Special features of this practical book are :

★ It is strictly in accordance with the latest syllabus by ICSE.

★ Subject matter is presented in simple and lucid manner.

★ Properly labelled diagrams are provided in experiment.

★ Sufficient theory is provided at the beginning of each experiment.

★ Tables are given for direct recording the observations.

★ Precautions are given for each and every experiment.

★ The procedure required for each experiment is written in an orderly.

★ Viva-Voce questions with answers are given for each experiment.

We sincerely hope that the present book will prove to be more useful for the students in their practical class.

Although we have taken care and laid down all efforts to remove any discrepancy which might have crept in, yet criticism or suggestions are always solicited from your end. Thanking you in anticipation for your co-operation.

—Author

SYLLABUS

CLASS-X (PRACTICAL)

(ICSE BOARD)

INTERNAL ASSESSMENT OF PRACTICAL WORK

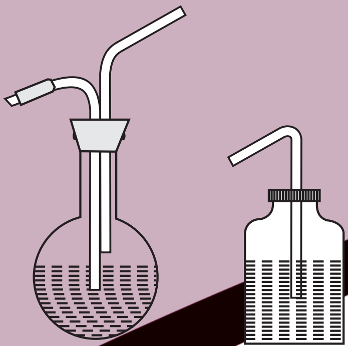
Candidates will be asked to carry out experiments for which instructions will be given. The experiments may be based on topics that are not included in the syllabus but theoretical knowledge will not be required. A candidate will be expected to be able to follow simple instructions, to take suitable readings and to present these readings in a systematic form. He/she may be required to exhibit his/her data graphically. Candidates will be expected to appreciate and use the concepts of least count, significant figures and elementary error handling.

Note: Teachers may design their own set of experiments, preferably related to the theory syllabus. A comprehensive list is suggested below:

1. Lever: There are many possibilities with a meter rule as a lever with a load (known or unknown) suspended from a point near one end (say left), the lever itself pivoted on a knife edge, use slotted weights suspended from the other (right) side for effort.

   Determine the mass of a metre rule using a spring balance or by balancing it on a knife edge at some point away from the middle and a 50 g weight on the other side. Next pivot (F) the metre rule at the 40 cm, 50 cm and 60 cm mark, each time suspending a load L or the left end and effort E near the right end. Adjust E and or its position so that the rule is balanced. Tabulate the position of L, F and E and the magnitudes of L and E and the distances of load arm and effort arm. Calculate MA = L/E and VR = effort arm/load arm. It will be found that MA < VR in one case, MA = VR in another and MA > VR in the third case. Try to explain why this is so. Also try to calculate the real load and real effort in these cases.
2. Determine the VR and MA of a given pulley system.
3. Trace the course of different rays of light refracting through a rectangular glass slab at different angles of incidence, measure the angles of incidence, refraction and emergence. Also measure the lateral displacement.
4. Determine the focal length of a convex lens by (*a*) the distant object method and (*b*) using a needle and a plane mirror.
5. Determine the focal length of a convex lens by using two pins and formula $f = uv/(u + v)$.
6. For a triangular prism, trace the course of rays passing through it, measure angles i_1, i_2, A and δ. Repeat for four different angles of incidence (say $i_1 = 40°$, $50°$, $60°$ and $70°$). Verify $i_1 + i_2 = A + \delta$ and $A = r_1 + r_2$.
7. For a ray of light incident normally ($i_1 = 0$) on one face of a prism, trace course of the ray. Measure the angle δ. Explain briefly. Do this for prisms with A = 60°, 45° and 90°.
8. Calculate the sp. heat of the material of the given calorimeter, from the temperature readings and masses of cold water, warm water and its mixture taken in the calorimeter.
9. Determination of sp. heat of a metal by method of mixtures.
10. Determination of specific latent heat of ice.
11. Using as simple electric circuit, verify Ohm's law. Draw a graph, and obtain the slope.
12. Set up model of household wiring including ring main circuit. Study the function of switches and fuses.

Teachers may feel free to alter or add to the above list. The students may perform about 10 experiments. Some experiments may be demonstrated.



Introduction

A scientist always likes to be in his laboratory for his internal joy and to satisfy his curiosity, to find the truth of the phenomenon happening around. He feels greatest joy to accomplish original work for the betterment of the human beings.

Science is both—*the product and the process.* The product of science is—what has been achieved by scientists, through their experiments, as *theories, laws* and *principles of science.* The process of science is the *ways, methods* and *skills through which scientific achievements are being attained.* **By adopting scientific method we can develop scientific temper.**

One develops scientific temper only when he/she adopts scientific method in solving problems. Thus, scientific temper *does not relate* to science teaching but also *helps us in solving problems in our day to day life. How can we develop scientific temper in our children*? The only ways are:

(*a*) *Demonstration of experiments* by the teacher by strictly adopting scientific method so that the students can visualise how does the scientist adopt and perform scientific method.

(*b*) Students themselves perform science experiments/practicals so that they themselves undergo the scientific processes such as *identification of problem, formulation, hypothesis, experimentation, collection of data, drawing inference on the basis of data* obtained. It also includes verification of experiments done by the scientists or other fellows. This inculcates *scientific temper* amongst students *i.e.*, a spirit of team work, rational thinking, acceptance of other's ideas, openmindedness, communication skill, manipulation of equipments etc. Experimentation by the students also provides **'Learning by doing'** and correlation between *the theory and practical verification.*

GENERAL INSTRUCTIONS

For doing practical work smoothly, effectively and more efficiently in the laboratory, students must follow the following important instructions:

1. A student must carry with him/her the following things, needed for doing experiments effectively.

Carry the following things on *each practical turn:*

(***a***) **Practical book**

(***b***) **Laboratory notebook** (Practical record book)

(***c***) **Auxiliary notebook** for keeping record before entering into the final practical record book.

(***d***) **A scale**

(***e***) **A pencil** (preferably HB)

(***f***) **A sharpener**

(***g***) **An eraser**

2. *Always occupy the seat allotted to you by your teacher in the laboratory.* This will save your time and will avoid confusion. It is always better if you seriously and silently reach your laboratory within 2–3 minutes after the previous period is over.

3. Preparation. Before actually performing an experiment, you must observe the following things:

(*i*) *Listen the instructions given by your teacher carefully.*

(*ii*) Clearly understand the **objective of the experiment, the theory of the practical, apparatus needed, precautions to be observed.**

(*iii*) A proper outline should always be made on the diagram sheet.

4. Apparatus. *Select right type of apparatus, check the apparatus before starting the work.* Never use an item of apparatus about which you have not been instructed earlier. Handle all the apparatus very carefully and *return the various items of apparatus to their respective place after use.*

If you use glassware or washable apparatus, you must wash or clean the apparatus after use before keeping the apparatus at its original position. *Carelessness not only causes the damage to the instrument or apparatus but may also cause injury or infection to the other students.*

5. Experimentation

(*i*) Follow precautions meant for the experiment strictly. Precautions are to be actually observed while doing the experiment.

(*ii*) Take at least three observations systematically and record them honestly on the practical notebook/record book. Never write your observation on a loose paper. Do not make the attempt to cook or overwrite observations in order to get good results.

(*iii*) Take every observation at least three times, even though their values each time may be exactly the same. You must know the proper plan for recording the observations. In most of the experiments, recording in *tabular form* is essential.

6. Cleanliness. See that your apparatus, seat and surroundings are neat and clean. Observe cleanliness at all levels of the work.

7. Disposal of waste. Dispose off waste material as early as possible.

8. Some Don’ts

(*i*) Do not enter the science laboratory in the absence of teacher.

(*ii*) Do not sit or lean or scribble on the working table.

(*iii*) Do not work with all the doors and windows closed.

(*iv*) Do not use anything from unlabelled containers.

9. Some Do’s

(*i*) Always clean your seat before leaving the laboratory.

(*ii*) Always wash your hands properly before leaving the laboratory.

(*iii*) Always report accidents, injuries or mishaps immediately to the laboratory incharges even though they may be of minor nature. You must understand the cause of accidents and the first-aid methods.

(*iv*) Always bring the following things to the laboratory on every practical turn:

(*a*) Laboratory notebook, (*b*) Practical book for guidance, (*c*) Auxiliary record book (small notebook), (*d*) A pencil, preferably HB, (*e*) Eraser, (*f*) Scale, (*g*) Dissection box (for biology practicals), (*h*) Fractional weight for weighing, (*i*) Apron.

10. Record keeping. Keeping a neat and systematic record of the experiment is most important. Record your observations immediately in clear, simple and precise language on the prescribed practical notebook. Make your own records, even if you are working in a group. Before leaving laboratory you must show your observations to your science teacher.

11. Record book. Use the record book approved by your science teacher. Record the experiment in your record book as directed by your science teacher. Most of the teachers suggest the following way:

PHYSICS EXPERIMENT

On the Left-Hand Page (*Blank Page*)

(*To be written in pencil or ink*)

1. Figure
2. Calculation

On the Right-Hand Page (*Ruled Page*)

(*To be written only in ink*)

Date.......	*Experiment No.......*	*Page No.......*

1. Aim/Objective.....
2. Materials Required/Apparatus.....
3. Theory/Basic Principle.....
4. Procedure.....
5. Precautions.....
6. Sources of error.....
7. Result/Inference/Interpretation with proper units.

PHYSICS EXPERIMENTS

PARTICULAR INSTRUCTIONS FOR DOING PHYSICS EXPERIMENTS IN THE LABORATORY

(*i*) In physics, *calculations should be done neatly using log tables.* Wherever possible *represent the observations with the help of a graph.*

(*ii*) The student must bear in mind the proper plan for recording the observations. In most of the experiments, recording in **tabular form** is essential.

(*iii*) *Tolerable percentage error* in physics is 5 to 10%. Percentage error is calculated by using the following formula :

$$\text{Percentage error} = \frac{\text{Result} - \text{Standard Result}}{\text{Standard Result}} \times 100$$

(*iv*) Always write the proper S.I. unit, if needed, with the result.

(*v*) For conducting experiments related to electricity, take proper care of insulation. There should not be loose connections. Avoid direct touch with the live wire.

Physical Quantities and their Measurement

In order to simplify the measurement of all physical quantities, it is essential to have some Fundamental Units. In 1960, the International General Conference of Weights and Measures adopted a system of units known as the *International System of Units* (S.I. units). In this system of units, there are six fundamental units.

Table: Seven Fundamental Physical Quantities and Their S.I. Units

S. No.	*Fundamental quantity*	*Unit*	*Symbol*
1.	Length (l)	metre	m
2.	Mass (m)	kilogram	kg
3.	Time (t)	second	s
4.	Electric Current (I)	Ampere	A
5.	Thermodynamic Temperature	Kelvin	K
6.	Luminous Intensity (I_V)	candela	cd
7.	Amount of the substance (n)	mole	mol

The quantities which are based on the fundamental quantities are known *as derived quantities* and their units as *derived units.* Some derived quantities along with their units are given below:

Table: Derived Quantities and Their S.I. Units

S. No.	*Derived quantity*	*S.I. Unit*	*Symbol*
1.	Area	metre^2	m^2
2.	Volume	metre^3	m^3
3.	Velocity	metre/second	ms^{-1}
4.	Acceleration	metre/second^2	ms^{-2}
5.	Density	kg metre^{-3}	kgm^{-3}
6.	Force	kg metre/second^2 or newton	kgm s^{-2} or N
7.	Work	newton metre or joule	Nm or J
8.	Energy	newton metre or joule	Nm or J
9.	Power	watt	W
10.	Moment of force	newton per metre	Nm^{-1}
11.	Pressure	newton/metre^2 or pascal	Nm^{-2} or Pa
12.	Heat	joule	J
13.	Specific heat	joule/kilogram/kelvin	J kg^{-1} K^{-1}
14.	Latent heat	joule/kilogram	J kg^{-1}
15.	Potential difference	volt	V
16.	Electrical resistance	ohm	Ω
17.	Frequency	hertz	Hz

While writing S.I. units and their symbols, following rules are observed:

1. *If a unit is derived from the name of a person (Scientist) initial letter of the unit is always written with capital letter, for example,*

Unit of electric current is Ampere (A).

Unit of thermodynamic temperature is Kelvin (K).

Unit of force is Newton (N).

2. *The units derived from the name of a person are never written in short. Instead their symbols are written with initial capital letter, for example,*

Symbol for Newton is **N** and not ν (nu).

Symbol for Ampere is **A** and not amp.

Symbol for Kelvin is **K** and not kel.

3. *The symbol of units, other than derived from the name of a person, are written with initial small letter, for example,*

Symbol of metre is **m**.

Symbol of gram is **g**.

Symbol of second is **s**.

4. *Unit symbols are never written in plurals, i.e.,* the symbols *for units remain unaltered in the plural, for example,* 75 kilograms is written as 75 kg *but not as* 75 kgs.

5. *If symbols are used for expressing the unit the symbol is not followed by a final full-stop, for example,*

The symbol of kilogram is kg and **not** (Kg.).

The symbol of joule is J and **not** (j).

However, the symbol may be followed by a full stop if it occurs at the end of a sentence as in rule (3) above.

6. *While writing the multiples and submultiples of a unit hyphen (-) is not used between the prefix and the unit, i.e., the combination of prefix and symbols is considered as one for example,*

kilometre is not written as kilo-metre.

7. *The use of double prefixes is avoided, instead higher order prefixes, if available, are used for example, for* milli-millimetre we use micrometre, for micromicrofarad we use picofarad and not micro-microfarad.

LEAST COUNT

Least count is the *smallest distance* that a measuring instrument (like scale, screw gauge, vernier callipers, Thermometer etc.) is *able to measure.* Thus, the *least count* of a spring balance is the value of one smallest division of the scale.

ZERO ERROR

When the pointer of the measuring instrument *does not coincide with zero* of the scale at resting stage, before or after measuring mass of a body, the instrument is said to have *zero error.*

The *zero correction is algebraically* added to observed values of masses to know correct masses.

ACCURACY OF AN INSTRUMENT

Accuracy of a measuring instrument can be expressed as half of its *least count*.

Table: Accuracy for Common Instruments Used in Laboratory

S. No.	*Measuring instrument*	*Least count*	*Accuracy*
1.	Metre scale	0.1 cm	0.05 cm
2.	Thermometre	1°C	0.5°C
3.	Stop watch	0.2 s	0.1 s

Generally, for measuring instruments provided in school laboratories measurement should be recorded upto *three significant figures.*

GRAPH

A graph is used to *study the relation between two inter-dependent physical quantities.* The graph shows how one quantity varies with the other. The quantity that is *made to alter at will* is called **Independent variable** and the *other quantity which varies as a result of this change* is known as **Dependent variable.** The graph may be a straight or curved line.

Advantages of the Graph

(*i*) The inter-dependence of two variables can be established easily, *e.g.*, *if the graph is a straight line, it indicates direct proportionality between the variables.*

(*ii*) The *mean value of ratio of two variables can be accurately obtained without rigorous mathematical calculations.*

(*iii*) The *probable value of variables* can be calculated with the help of graph within or beyond the observed range by *intrapolation and extrapolation.*

(*iv*) It is easy to find the *variation of observed values from the mean value* without lengthy numerical computation.

(*v*) An important advantage of graph is that some of the salient features of a given experimental data can be seen visually, which cannot be easily concluded by merely looking at the experimental data. For example, the point of *maxima, minima or inflexion* can be easily known by careful observation of the graph representing the experimental data.

Plotting of Graph

Graphs are generally plotted on a paper ruled in millimetres. Given below are some of the hints for plotting a graph.

(*i*) **Plotting X-axis and Y-axis on the graph paper.** Draw *two thick lines at right angles to each other* at the bottom of the left hand edge of the graph paper. The horizontal thick line known as **X-axis**, generally represents the *Independent Variable*. The vertical line known as **Y-axis** represents the *Dependent Variable.*

(*ii*) **Marking the co-ordinate axis.** Mark the co-ordinate axis denoted by **X-axis** and **Y-axis**, each with the *arrow head* for representing with proper units so that one can understand at a glance what the graph is about.

(*iii*) **Selection of suitable scale.** Note the variation of **both the variables—***Dependent and Independent variables,* range and *choose a suitable scale* as per number of divisions available on the graph paper.

(*iv*) **Denoting the scale adopted.** Note down the scale chosen for X-axis as well as Y-axis *on the top of the graph paper*.

(*v*) **Note down the title of the graph on the top of the graph paper.**

(*vi*) **Marking the point of intersection.** The points of intersection, of different pairs of values of the variables should be *marked with small circles* (O) *around each of them or may be marked with a cross* (×) so that they can be easily located or seen.

(*vii*) **Drawing of the Graph:**

(*a*) Now draw a smooth curve (free hand) which passes through the maximum number of points. It is advisable to use French curves or flexible spoke to get smooth curve.

(*b*) If the points appear to be in a straight line, then draw a line with the help of a metre rod passing through most of the points.

(*c*) If the points do not lie on a straight line, then draw a line between the points so that few points lie on one side and few on the other and the graph appears symmetrical with respect to the points.

Note. It is not necessary that the origin of the graph begins with zero on the axis.

CHEMISTRY EXPERIMENTS

PARTICULAR INSTRUCTIONS TO PERFORM CHEMICAL EXPERIMENTS IN THE LABORATORY

(*i*) Don't *touch* any chemical/reagent (solid or liquid) *without the permission of your teacher.*

(*ii*) Do not *taste* or *smell* any chemical without the permission of your teacher.

(*iii*) Always wear laboratory coat while performing/doing experiments/practicals so that spill of any chemical may not spoil your clothes/uniform.

(*iv*) Keep the windows open while working in the laboratory to allow gas fumes to escape out of the lab. If exhaust fans are there in the laboratory, keep them on while performing experiments in chemistry.

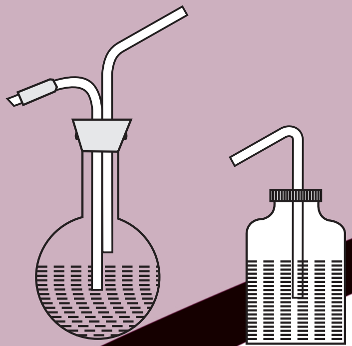
(*v*) Replace the reagent/chemical bottles in their proper place after their use.

(*vi*) Light the matchstick before switching on the LPG burner so that the fuel gas may not ooze out before use.

(*vii*) Make sure that there is no leak of gas. If you feel so, do not ignite matchstick or gas lighter. Also, do not switch on/off the light/fans, if you feel there is a leakage of LPG gas in the laboratory.

(*viii*) Always check that the gas burners are properly turned off, after use, during the experimentation.

(*ix*) Keep the test tube tilted away from your face/body.



UNIT I

1 CHAPTER Levers

EXPERIMENT 1.1

AIM OF EXPERIMENT

To determine the mass of a metre rule using it as a lever.

THEORY

The center point of gravity of a body is a point through which the weight of the body demonstrations, or seems to act. A meter rule has a uniform shape and a steady thickness thus the center point of gravity will be a point precisely middle.

ACCORDING TO THE PRINCIPLE OF MOMENTS

- The states that an object is in equilibrium if the sum of all anticlockwise moments about the pivot is equal to the sum of all clockwise moments about the same pivot.
- If a meter rule is balanced horizontally at any point, this means that the clockwise moments and the anticlockwise moments must be equal.

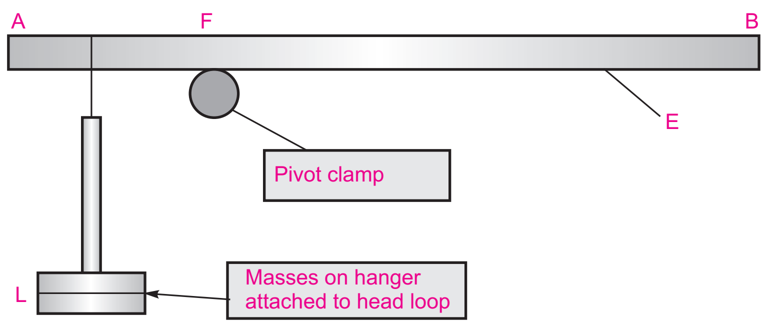


Fig. 1.1

$$\text{Load} \times \text{Load arm} = \text{Effort arm} \times \text{Effort}$$

$$L \times AF = E \times BF$$

$$\text{Advantage of lever,} \quad \text{M.A.} = \frac{\text{Load (L)}}{\text{Effort (E)}}$$

$$\text{V.R.} = \frac{\text{Distance move by effort in time } (t)}{\text{Distance move by load in time } (t)}$$

$$= \frac{\text{Effort (BF)}}{\text{Load arm (AF)}}$$

where, V.R. = Velocity ratio of lever

L = Load

E = Effort

PROCEDURE

1. Measure and note the value of small division on the metre rule.
2. A weight suspend from the metre rule with its flat portion vertical in a loop and set the position loop until metre rule is constant in horizontal position.
3. Mark the position on the loop on the metre rule as center of gravity. You will see that center of gravity of metre rule lies at 50 cm.
4. According to the figure 1.2, set the apparatus, a fulcrum vertically near to the center of the gravity of the metre rule (60 cm note it). The metre horizontally placed on the fulcrum, its flat edge, if the rule will depress on the left side due to its own weight.

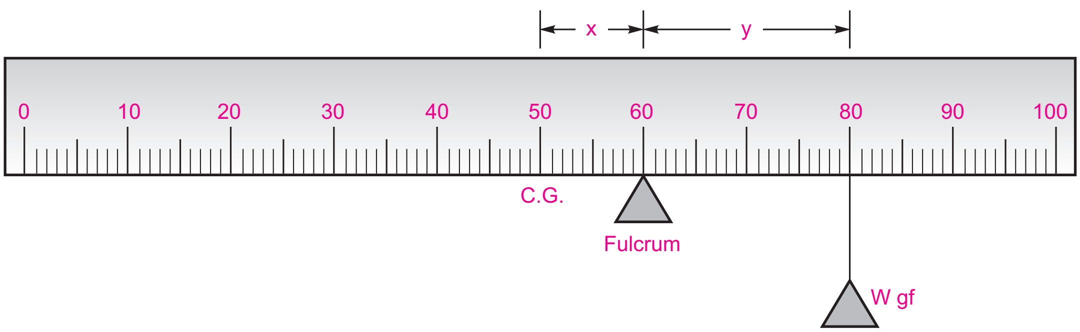


Fig. 1.2

5. A weight W gf with a string and suspend it on the right side of the fulcrum by making the loop in the string. Set the metre position such that the metre rules balance itself in the horizontal position.
6. Write down the weight W at the distance of x of fulcrum from center of gravity of the metre rule and the distance y of the weight W from the fulcrum.
7. Do the same experiment of several times with different weight for each weight read the values of x and y.
8. Determine the mass of metre rule every time using formula

$$m = \text{W}\left(\frac{x}{y}\right)g, \text{ and take its mean value.}$$

OBSERVATION

S. No.	Known weight W (in gf.)	Distance x (in cm)	Distance y (in cm)	Mass of metre rule $m = W (x/y)$ g
1.				
2.				
3.				
4.				

Values of small division of metre rule = ... cm.

Mean value of m = ... cm.

Mean m is correct to 3. S. f. = ... cm.

RESULT

Mass of the metre rule m = ... g.

PRECAUTIONS

1. If we change the position of effort, we take care of fulcrum position is constant.
2. If we trying different position of weight and effort of the right side then you should be hold the metre rule at fulcrum with your one hand.
3. You should be check the metre rule in the horizontal position.
4. If the approximate balance point has been achieved, keep side your hand to the fulcrum.

VIVA–VOCE

Q. 1. What is lever?

Ans. A rigid rod is a called lever, which is used to rotate a heavy or firmly fixed load with one end when the some forces applied on other end.

Q. 2. What is the mechanical advantage of a lever?

Ans. The mechanical advantage of a lever, which is balance the ratio of load to effort.

Q. 3. What is load in your experiment?

Ans. A weight is suspending vertically on the metre rule in downward due to the centre of gravity (c.o.g.).

Q. 4. Explain the principal of moment is in equilibrium.

Ans. The states that an object is in equilibrium, if the sum of all anticlockwise moments about the pivot is equal to the sum of all clockwise moments about the same pivot.

Q. 5. Convert a weight of 10 gf info dynes.

Ans. Weight = 10 gf = 10 × 980 = 9800 dynes.

Q. 6. SI unit of weight is ______________.

Ans. Newton (N)

Q. 7. What are clockwise and anticlockwise moment?

Ans. The moment of a which tend to rotate the body in the anticlockwise direction are called anticlockwise (or + ve) moments and those which tend to rotate the body in the clockwise direction are called (or – ve) moments.

Q. 8. What do you mean center of gravity of a body?

Ans. It is a point on the body where the whole weight of the body is supposed to be concentrated.

Q. 9. What are the factor on which the moments of a force about an axis of rotation depend?

Ans. The moments of a force depends upon the following factor:

I. The magnitude of the force

II. Perpendicular distance between the axis of rotation and of action of the force.

Q. 10. Why should the scale be of uniform thickness?

Ans. For uniform thickness of the scale, the CS will be at the centre of the scale.

Q. 11. Will you weight the same, if you move from equator to the poles?

Ans. No, the weight (W = mg) will be more at the poles because acceleration due to gravity is more at the poles.

Q. 12. What is measured by a physical balance, weight or mass?

Ans. A physical balance measures mass.

2

CHAPTER

Metre Rule Based on Levers

EXPERIMENT 2.1

AIM OF EXPERIMENT

To use a metre rule as a lever to prove that M.A. < V.R., M.A. = V.R. and M.A. > V.R.

PROCEDURE

1. Arrange the metre rule with the help of fulcrum F, whereas the point marked on the metre 40 cm, as we show the below in figure.

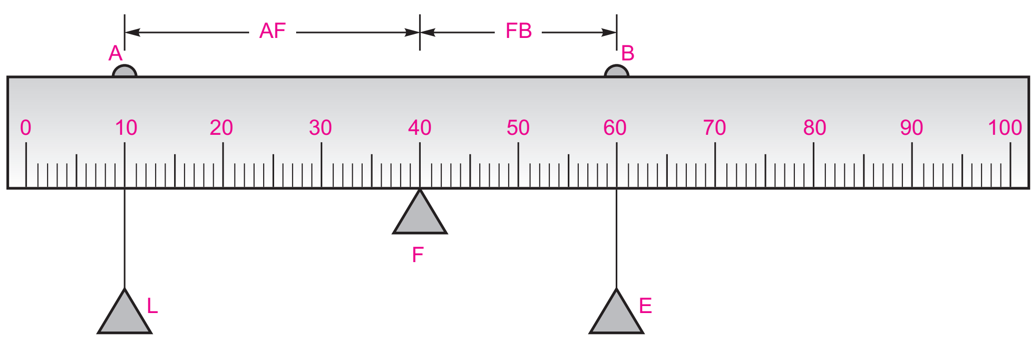


Fig. 2.1

2. A weight is suspended on the metre that weight is called load L, whereas the point marked on the metre 10 cm. and another weight suspended from the right side of metre rule that weight is called effort E, whereas the point marked on the metre 60 cm.
3. Read the position of Effort, load and fulcrum on the metre rule.
4. If we change the position of fulcrum F at 50 cm whereas the point marked on the metre. Repeat the experiment as same in steps 1 and 2.
5. If we change the position of fulcrum F at 60 cm whereas the point marked on the metre. Repeat the experiment as same in steps 1 and 2.

6. The each three case of above step, Calculate M.A. and V.R. with the help of formulas.

$$\text{M.A.} = \frac{\text{L}}{\text{E}} \text{ and V.R.} = \frac{\text{Effort arm (BF)}}{\text{Load arm (AF)}}.$$

OBSERVATION

S. No.	*Load L (in gf)*	*Effort E (in gf)*	*Position of fulcrum F in cm*	*Position of load A (in cm)*	*Position of effort B (in cm)*	*M.A. = L/E*	*V.R. = BF/AF*
1.			40				
2.			50				
3.			60				

RESULT

1. According to above step 1, when fulcrum is at 40 cm, here we can find that M.A. > V.R., where weight of meter rule (= m gf) loaded down on the centre of gravity at acts like effort. If the load is in equilibrium, L × AF = m × 10 + E × BF.

   $$6 = m \times 10 + \text{E} \times \text{BF}.$$

2. According to the 2$^{\text{nd}}$ step, when fulcrum is at 50 cm mark, here we can find that M.A. = V.R. where the weight of metre will be constant. In equilibrium, L × AF = E × BF.
3. According to the 3$^{\text{rd}}$ step, when fulcrum is at 60 cm, here we can find that M.A. < V.R., where weight of meter rule (= m gf) loaded down on the centre of gravity at acts like effort. If the load is in equilibrium, L × AF + m × 10 = E × BF.

VIVA-VOCE

Q. 1. Explain the term of velocity ratio.

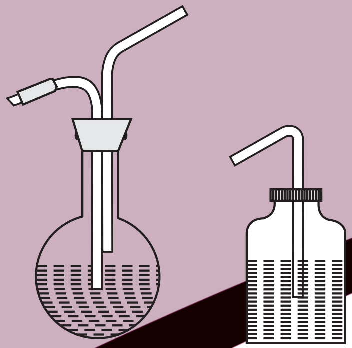
Ans. The distance between the same times travels in the effort to the load, that travel ratio is known as velocity ratio.

Q. 2. How do you change the mechanical advantage of lever in your experiment?

Ans. If fulcrum position will change then weight of metre will goes up and down load position on metre rules (M.A. < V.R.) or effort (M.A. > V.R.).

Q. 3. How are the mechanical advantage and velocity ratio of a metre rule related when is provided at its centre of gravity?

Ans. M.A. = V.R.



UNIT 2

3
CHAPTER

Frictional Force

EXPERIMENT 3.1

AIM OF EXPERIMENT

To determine the effort required to roll a roller up an inclined plane and hence to determine its mechanical advantage and velocity ratio.

REQUIRED APPARATUS

1. An inclined plane
2. Roller
3. Weight box
4. Pan
5. Protractor and spring balance.

THEORY

An inclined plane is a simple machine, whose mechanical advantage is M.A.

$$\text{M.A.} = \frac{\text{Load}}{\text{Effort}} = \frac{\text{L}}{\text{E}}$$

And velocity ratio,

$$\text{V.R.} = \frac{l}{h}$$

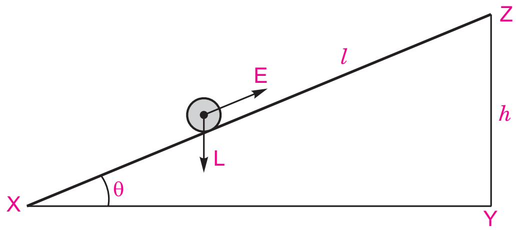


Fig. 3.1

where, l = length of inclined plane
h = height of inclined plane

PROCEDURE

1. Fix the angle of inclination θ of the inclined plane and note the values of l and h.
2. Note the weight of the roller with the help a spring balance and let it is L.
3. Tie the end of the string with the hook of the roller and pass it over the pulley. Tie the other end to the pan.

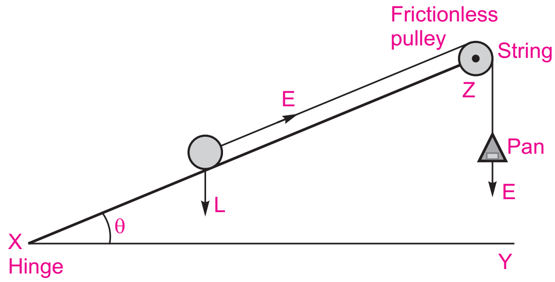


Fig. 3.2

4. Note the weight of the empty pan. Let it be 'w'.
5. Add weights to the pan gradually till the roller just begins to slide. Let the total weights be 'W'. Hence the effort required is 'E = W + w'.
6. Repeat the experiment for different angles of inclination.
7. Calculate the M.A. and V.R. for each set.

OBSERVATION

1. Length of inclined plane l = ... cm.
2. Weight of the roller L = ... gf.
3. Weight of the pan w = ... gf.

S. No.	*Vertical height of the inclined plane h*	*Total weight placed on pan w*	*Effort E = W + w (in gf)*	*M.A. = L/E*	*V.R. = l/h*
1.					
2.					
3.					
4.					

PRECAUTIONS

1. Clean and polish the surface of the inclined plane to minimize the friction.
2. Pulley should be oiled.
3. Pan should not touch the table or the inclined plane.
4. Increase the weight of the pan gradually.
5. The inclined plane should be knocked gently each time.

RESULT

It is found that for each angle of inclination, M.A. < V.R. as the friction between the roller and the inclined plane increases the effort required.

VIVA-VOCE

Q. 1. Explain the term mechanical advantage.

Ans. The ratio between the load moved by a roll to the effort applied on it is called mechanical advantage.

Q. 2. Define the term velocity ratio.

Ans. It is the ratio at which effort is applied to the velocity at which the load moves.

Q. 3. The effort want to be same to W or less than W, if a body of weight W is lifted up through an inclined plane?

Ans. The effort want to be less than W, if the body is lifted up to through at inclined plane.

Q. 4. Can you say, how to use of inclined plain in your daily life?

Ans. In daily life, we can use an inclined plane to load a truck.

Q. 5. What is mechanical advantage of an inclined plain?

1. Equal to 1
2. Greater than 1
3. Less than 1

Ans. The mechanical advantage of an inclined plain is always greater than 1.

Q. 6. Define the term efficiency of a machine and state its unit.

Ans. The ratio between the mechanical advantage and velocity ratio is called its efficiency. It is a pure number and has no units.

Q. 7. How will you determine the order of a lever?

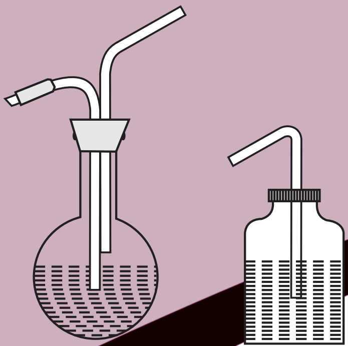
Ans. Locate which amongst the effort, the fulcrum or the load is in the middle, the lever is of the second order. If the effort is in the middle, the lever is of the third order.

Q. 8. What is the V.R. of a pulley block and tackle?

Ans. V.R. of a pulley block and tackle is equal to number of segment supporting the lower block.

Q. 9. What is the relation between M.A., V.R. and efficiency?

Ans. M.A. = $\eta \times$ V.R.



UNIT 3

4

CHAPTER

Experiment Based on Pulley System

EXPERIMENT 4.1

AIM OF THE EXPERIMENT

To determine the velocity ratio (V.R.) and mechanical advantage (M.A.) of a given pulley system.

REQUIRED APPARATUS

1. Meter scale
2. Vertical stand
3. Weight box
4. Pulley
5. A bench

THEORY

A basic pulley comprises of a wheel on a fixed axle, with a groove along the edges to guide a rope or cable.

$$\text{Mechanical advantage (M.A.)} = \frac{\text{Load (L)}}{\text{Effort (E)}}$$

Here, Load = the weight of an object

Effort = the amount of force required to lift or move this object.

When you put two or more wheels together, and run a rope around them, you have created a great lifting machine. The machine is defined as ratio of distance moved by effort to the distance moved by load in the same time.

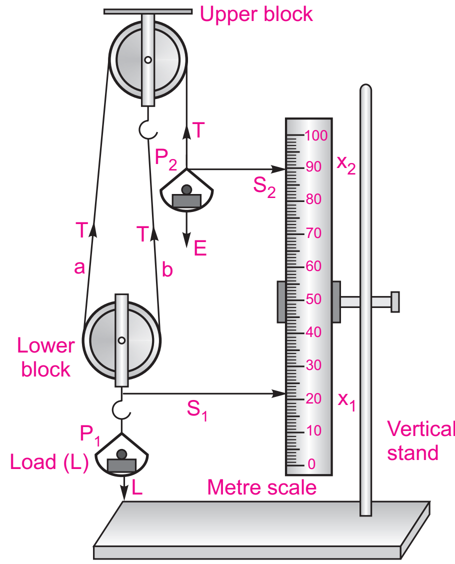


Fig. 4.1

$$\text{Velocity ratio (V.R.)} = \frac{(D_E)}{(D_L)}$$

where, Distance moved by effort = D_E, and Distance moved by Load = D_L.

As you add more pulleys, you increase your mechanical advantage and it becomes very easy to lift the same load.

The trade-off is that as you increase the number of pulleys, you require a greater amount of rope to achieve the same result. Since you have decreased the effort needed to lift the load, you have to apply the force for a longer period of time.

For instance, it takes more effort to lift the load in a one pulley system. In other pulley system it takes less effort

According to the figure, here two pulleys showing in the figure, one pulley P_1 attached with the hock of upper fixed block and other pulley P_2 attached with hock in lower movable block. Load L which can be placed while another pan pulley P_2 is attached at the free end of string on while effort can be applied. T is tension same applied along the entire length string.

Expecting that the string is massless, there is no friction in the heading of pulleys and the weight of lower with pulley is immaterial.

$$L = 2T \text{ and } E = T$$

$$\text{Mechanical advantage (M.A.)} = \frac{L}{E} = \frac{2T}{T} = 2$$

If the L load is climbed by a separation x every section a and b of string gets relaxed by a length x, so the exertion E must be moved around a separation $2x$ to keep the string tight.

$$\text{Velocity ratio (V.R.)} = \frac{D_E}{D_L} = \frac{2x}{x} = 2$$

PROCEDURE

Here we can experiment is done in two parts

1. To determine the velocity
2. To determine the mechanical advantage

TO DETERMINE THE VELOCITY

1. According to the figure arrange the pulley system after it select a point on the scale from the hook S_1 and S_2 without touch the meter scale but must be readable position.
2. You should be read the least count scale. And write on the note the initial position of the pointer S_1 and S_2.
3. The pointer S_1 is the position of x_1 and S_2 position is the x_2 showing in the scale, note the initial position of both pointer S_1 and S_2.
4. The segment a and b hold on the string and pulley lift the lower block up x = 20 cm, then you can read the loaded segment of both a and b.
5. See the figure and pull the effort p_2 down to remove the slack in both segment a and b of the string and read the final position on the scale. If the pointer x_1' of the S_1 and x_2' of S_2 on the meter scale.
6. The repeat the experiment 4 and 5 time of different values of x.

TO DETERMINE THE MECHANICAL ADVANTAGE

1. Write down on the note the initial position x_1 and x_2 of the S_1 and S_2.
2. a and b are two segment hold of the string and place a weight, assume 100 gf on the pan pulley p_1 from the weight box, and write down the load L. After set the weight of pan pulley p_2 on the segment a and b of string and the position S_1 and S_2 that's initial position x_1 and x_2 are respectively.
3. Do the same step several of times.

OBSERVATION

For the velocity ratio

1. Least count of the meter scale = ……… cm.
2. Initial position of pointer S_1, x_1 = ……… cm.
3. Initial position of pointer S_2, x_2 = ……… cm.

S. No.	*Final position of pointer S_1, x_1' (cm)*	*Final position of pointer S_2, x_1' (cm)*	*Displacement of load $D_L = (x_1' \sim x_1)$*	*Displacement of load $D_E = (x_1' \sim x_2)$*	*Velocity ratio D_E/D_L*
1.					
2.					
3.					

Mean Velocity Ratio = …………

For mechanical advantage

S. No.	*Load L in gf*	*Effort E in gf*	*Mechanical advantage = L/E*

Mean mechanical advantage = …………

RESULTS

1. The two pulley system is given velocity ratio = ...
2. The two pulley system is given mechanical advantage = ...

PRECAUTIONS

1. Pulley should be reducing friction and oiled.
2. The string should be strong and lighted.
3. The both pointer should be not touching on the meter scale.

VIVA-VOCE

Q. 1. What is a pulley?

Ans. Pulley is a grooved wheel that can turn readily on an we.

Q. 2. What is a single fixed pulley? What is its mechanical advantage?

Ans. It is a pulley whose axis of rotation is fixed. Its mechanical advantage is 1 *i.e.*, E = L.

Q. 3. What is a movable pulley? What is its mechanical advantage?

Ans. A single movable pulley is the one whose axis of rotation can change. Its mechanical advantage 2 *i.e.*, it can multiply force.

Q. 4. Define mechanical advantage.

Ans. It is defined as the ratio of the load lifted or resistance overcome to the effort applied.

Q. 5. Define velocity ratio.

Ans. It is the ratio of distance through which the effort is applied to the distance through which load is lifted.

Q. 6. Can mechanical advantage be less than one?

Ans. Yes, it can be less than one.

Q. 7. What is the relation between mechanical advantage and V.R. in the case of (*i*) ideal machine (*ii*) real machine?

Ans. In an ideal machine, V.A. = M.A. In a real machine, where friction is also present M.A. < V.R.

Q. 8. What is the principle of a machine?

Ans. Work done by a machine = Work done on the machine.

Q. 9. Define efficiency of a machine.

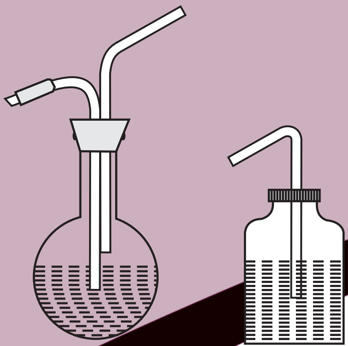
Ans. It is defined as the ratio of the output of the machine to its input.

Q. 10. How can you increase mechanical advantage of a pulley block and tackle?

Ans. By increase the number of string supporting the lower block.

Q. 11. Two pulley block and tackle A and B have the same number of the pulley however in one of them a friction id present. Which of them has higher V.R.?

Ans. Both of them have the same V.R., because V.R. does not depend upon the force of friction.



UNIT 4

5 CHAPTER

Refraction through a Glass Slab

EXPERIMENT 5.1

AIM OF EXPERIMENT

To trace the of different rays of light refracting through a rectangular glass slab at different angle of incident and to measure (*i*) the angles of incident, refraction and emergence (*ii*) the lateral displacement.

REQUIRED APPARATUS

1. Rectangular glass slab
2. A drawing box board
3. A sheet of white paper
4. Drawing pins
5. Protractor and metre scale
6. Pins
7. Pencil

THEORY

According to figure, a light ray incident on the surface of rectangular glass slab. Where, a light ray AO, surface PQ and PQRS is rectangular glass slab. A light ray passing in to the glass, it bend towards the normal NOM at the point O and takes a path OB inside the glass slab as refracted ray.

OB is a reflected ray that is incident on the surface SR of the emerging out of glass. It bends away from the normal N_1BM_1 at the point of B, and taking the path BC as emergent ray.

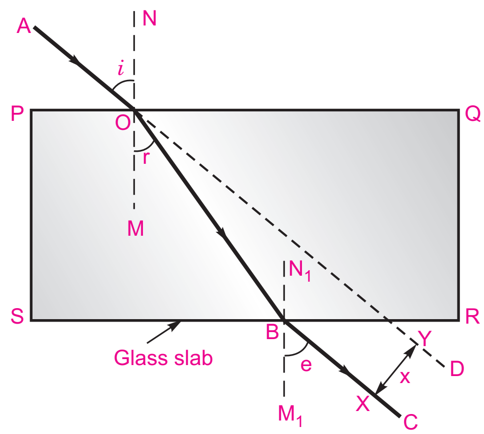


Fig. 5.1

According to figure, three major angles made on rectangular glass slab,

1. The angle of incident ∠AON = i.
2. The angle of reflection ∠BOM = r.
3. The angle of emergence $\angle CBM_1 = e$.

The incident ray AO passing parallel to emergence ray BC; however it is not in accordance with it. Hence the angle of emergence e is equivalent to the angle of incident i. XY is the perpendicular distance between incident ray OD and emergence ray BC, this called the lateral displacement, where the displacement denoted by x.

PROCEDURES

1. Take a drawing board and fix a white sheet of paper on it with the help of drawing pins.
2. Place the rectangular glass slab in the centre of the white paper and draw its outline boundary with pencil.
3. Mark this rectangular figure obtained as PQRS.
4. On one side of this figure, i.e., PQ take one point O, draw the normal NOM.
5. With the help of a protractor draw an angle of 30° with the ON. Fix two pins '*a*' and '*b*' on the ray of this angle, the distance between the pins should be 5 cm.
6. Put the glass slab on the rectangular figure PQRS.

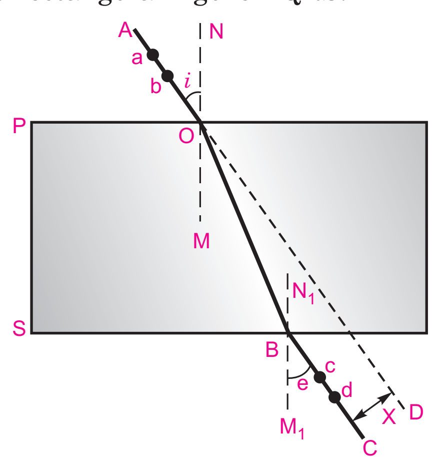


Fig. 5.2

7. Now, look through the glass slab from side RS and fix pin 'c' and 'd' such that when seen through the glass slab all the pins lie in straight line, [*i.e.*, Pins, a, b, c and d should lie in straight line when seen through the glass slab].
8. Now, remove the pins a, b, c and d one by one and draw small circles around the pin points.
9. Remove the glass slab.
10. Join points c and d such that it meets RS at point B.
11. At point B draw the normal N_1BM_1.
12. Join points O and B with the pencil.
13. Measure the angles formed at PQ and RS, *i.e.*, the incident angle $i = \angle AON$, refracted angle $r = \angle BOM$ and emergent angle $e = \angle CBM_1$.
14. Extend ray AO with scale and pencil in dotted line. It will be parallel to ray BC. The distance between these two parallel rays is called lateral displacement (x).
15. Measure the lateral displacement.
16. Repeat the above procedure for several times with different angles.

OBSERVATION

S. No.	*Angle of incident* $i = \angle AON$ *(in degree)*	*Angle of refraction* $r = \angle BOM$ *(in degree)*	*Angle of emergence* $e = \angle CBM$ *(in degree)*	*Lateral displacement* x *in cm*
1.				
2.				
3.				

RESULTS

1. The angle of incident i, is greater than refraction angle r, light ray interring into the glass slab.
2. The angle of incident is equal to the angle of emergence; this both rays are parallel to each other.
3. If angle of incident increases then lateral displacement also increases.

PRECAUTIONS

1. All pins should be in vertical position.
2. The pins distance should be 5 cm.
3. The glass slab should be clean and transparent.

VIVA-VOCE

Q. 1. What do you mean by refraction?

Ans. The bending of light as it goes from one medium into another medium is called refraction.

Q. 2. What is the angle of refraction, when the angle of inclined is zero?

Ans. When $i = 0$, $r = 0$, *i.e.*, the ray goes un-deviated.

Q. 3. What is optical density?

Ans. Optical density of a medium is defined as the ratio of the velocity of the light in vacuum velocity of the light in the medium.

Q. 4. How does the path of ray change when it enters a glass slab?

Ans. When the ray enters from the air to glass, it bends towards the normal.

Q. 5. Does reflection take place along with refraction?

Ans. Yes, a small amount of light gets reflected at surface of separation of two media.

Q. 6. What do you mean by lateral displacement?

Ans. The perpendicular distance between the initial direction of incident ray and the direction of emergence ray is called lateral shift.

Q. 7. How is the angle of incidence *i* and the angle of emergence *e* related in your experience?

Ans. The angle of emergence e is equal to the angle of incidence.

Q. 8. What is the refractive index of an opaque medium?

Ans. Infinite because its refractive index is less.

Q. 9. Can angle of reflection be greater than the angle of incidence?

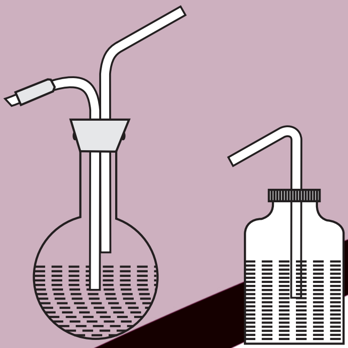
Ans. Yes, when the ray of light suffers refraction from the optically denser to the optically rarer medium.

Q. 10. Define refractive index in term of the velocity of light.

Ans. Refractive index of a medium is defined as the ratio of the velocity of the light in vacuum to the velocity of the light in the medium.

Q. 11. A ray of light is travelling from glass of water, will it speed up to down.

Ans. It will speed up because the speed of light is more in a rarer medium. Water is rarer than glass.



UNIT 5

6

CHAPTER

Focal Length of a Concave Mirror on Parallax Method

EXPERIMENT 6.1

AIM OF EXPERIMENT

To determine the approximate focal length of a concave mirror by the distance object method and then to determine its focal length using one pin method removing parallax.

REQUIRED APPARATUS

1. Concave mirror
2. Stand
3. Screen
4. A sheet of paper
5. Pins
6. Optical bench

THEORY

For a separation object, the image is organized by concave mirror at it center. The image is real inverted and lessened.

According to the figure, approximate focal length of a concave mirror can be determine by focusing of the real image of a distant object on the screen wall, but for an object at centre of curvature of concave mirror, a real inverted image of the same size, is formatted at the center of curvature itself. If focusing the inverted image of a pin on itself, the radius of curvature of concave mirror can be determined.

Half of radius of curvature of concave mirror = focal length.

$$\text{Focal length} = \frac{\text{Radius of concave}}{2}.$$

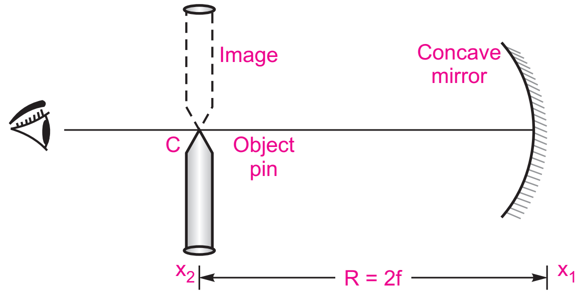


Fig. 6.1

PROCEDURE

1. Determine and read the approximate length of mirror. A sheet paper is placed in the front of concave mirror and measure the distance of focal length *f*, in between mirror and sheet paper.
2. The concave mirror placed on an upright stand is placed on optical bench, near one side of the end.
3. Write down the values of division through the optical length.
4. A pin is adjusted on upright stand and keeps it on the optical bench at distance of twice approximate focal length *f* from the mirror.
5. Set the pin height, nearly at the level of pole of the mirror as shown in figure.
6. Move the pin upright on the optical bench slowly and adjust it position such that there no parallel *x* between the trip of the pin and the outing of its image seeming inverted in the mirror. The distance of the pin from the mirror is equal to the radius of curvature of the mirror.
7. Write down the position upright mirror, say x_1 cm and other side of the position of the pin say x_2 cm on the optical bench. Half of distance is giving the focal length $f = x_1 \sim \frac{x_2}{2}$.
8. The same above step repeat several times and fine the value of *f*.

OBSERVATION

1. Approximate focal length of concave mirror *f* = ... cm.
2. Value of one division on optical bench = ... cm.
3. Mean value of *f* = ... cm.
4. Mean value of *f* correct up to 3 *s. f.* = ... cm.

S. No.	*Position of mirror up right x_1 (cm)*	*Position of mirror upright x_2 (cm)*	*Focal length $f = x_1 + x_2/2$ (in cm)*

RESULTS

1. Given the concave mirror, approximate focal length = ... cm.
2. Given concave mirror, focal length = ... cm.

PRECAUTIONS

1. Do not set parallel between the tip of the pin and its inverted mirror.
2. Height of the tip of the pin must be near at the level of middle point of the mirror.

VIVA-VOCE

Q. 1. What is a mirror?

Ans. A surface which reflects most of the light incident on it, is called a mirror.

Q. 2. What is meant by reflection of light?

Ans. The return of a light ray into the same medium after striking a surface is called the reflection of light.

Q. 3. State the laws of reflection of light.

Ans. (*i*) The angle of incidence is equal to the angle of reflection.

(*ii*) The incident my, the reflected ray and the normal lie in one plane.

Q. 4. How is the focal length of a concave mirror related to its radius of curvature?

Ans. Focal length = 2 × radius of curvature.

Q. 5. When does a concave mirror form a real image?

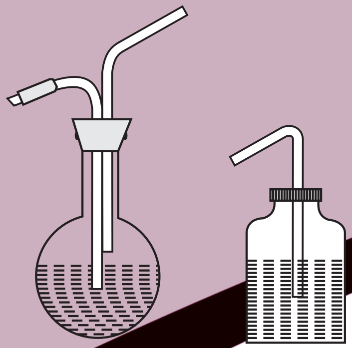
Ans. When the object lies beyond the focus of concave mirror.

Q. 6. What is the position of object relative to a concave mirror when its image coincides with the object?

Ans. The object is at the centre of curvature of concave mirror.

Q. 7. How do you remove parallax in your experiment?

Ans. When tip of the pin appears to be coinciding with the tip of its inverted image, the eye is moved a little to its left or right. When the object pin and its image both appear to move simultaneously to the left or right, the parallax is said to be removed.



7

CHAPTER

Focal Length of a Concave Mirror on Distance Object Method

EXPERIMENT 7.1

AIM OF EXPERIMENT

To determine the approximate focal length of a concave mirror by the distant object method, and then to determine the focal length using on illumination object (ray box or candle) and a screen.

THEORY

The distance of the image from the concave mirror changes as the distance of the object changes and these distances are only the same when the object is at the center of the curvature.

For a concave mirror:

If the image is real, $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

If the image is virtual, $\frac{1}{u} - \frac{1}{v} = \frac{1}{f}$

where, f is the focal length.

u is the distance from the object (cross threads) to the mirror

v is the distance from the image (screen) to the mirror.

Example,

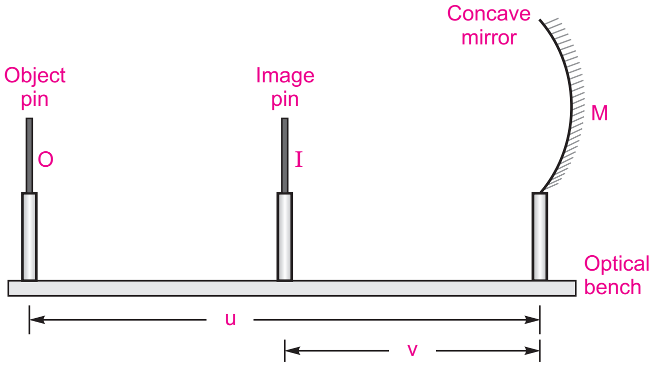


Fig. 7.1

PROCEDURE

1. Determine the approximate focal length of the given concave mirror by obtaining on the wall the image of a distant tree.
2. Mount the given concave mirror on a stand and fix one pin on the other stand, then place them on the optical bench as shown in the diagram.
3. Now keep the object needle O in front of the mirror M and beyond C. Take a second needle I and place it in between the mirror and the object needle. Move the needle I, until there is no parallax between the image of O and I on moving the eye from side to side. Measure the distance MO (u). Also measure the distance MI (v). This gives the observed object and image distance.
4. Every the position of the object bringing it progressively closer to the mirror taking care to see that a real image is obtained in each case. This will be so if object is at a distance greater than the focal length from the mirror. Repeat the above mentioned procedure to find the value of MO and MI in each case. Take at least six observations in this manner.
5. Plot a graph v vs. u. This will be curve. Draw a line OP making an angle of 45°. With either axis or meeting the curve at point P.

OBSERVATION

S. No.	*Position of the mirror M (in cm)*	*Position of the pin O (in cm)*	*Position of the pin I (in cm)*	*Object distance C (in cm)*	*Image distance V (in cm)*
1.					
2.					
3.					
4.					
5.					

1. Range of Optical bench = ... cm.
2. Least count of Optical bench = ... cm.
3. Rough focal length of concave mirror f_L = ... cm.

Graph : v vs. u (in cm).

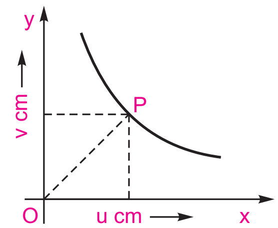


Fig. 7.2

CALCULATION

From Graph Co-ordinates (u, v) of point P is ....

$$F = \frac{u}{2} = \frac{v}{2} = \text{...........} \text{ cm.}$$

RESULT

Focal Length of given Concave Mirror = ... cm.

VIVA-VOCE

Q. 1. What is a concave minor?

Ans. A concave mirror is a spherical minor from which reflection takes place from the hollow (or concave) surface.

Q. 2. Does a concave minor always form a real image?

Ans. No. A concave minor forms a real image only if the object lies beyond its focus.

Q. 3. When is the image formed by a concave mirror virtual?

Ans. The image formed by a concave mirror is virtual for an object placed between its pole and focus.

Q. 4. Can you obtain a virtual image on screen?

Ans. No.

Q. 5. In your experiment, where do you keep the object?

Ans. Between focus and centre of curvature of concave mirror.

Q. 6. Where is the image formed?

Ans. Beyond the centre of curvature.

Q. 7. Is the image diminished or magnified?

Ans. Magnified.

Q. 8. How are the object distance u, image distance v and focal length f related?

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

Q. 9. Tell me one use of concave minor.

Ans. As a shaving mirror.

UNIT 6

8

CHAPTER

Focal Length of a Convex Lens Using a Plane Mirror Method

EXPERIMENT 8.1

AIM OF EXPERIMENT

To determine the focal length of a convex lens using a plane mirror and a pin with a retort stand.

REQUIRED APPARATUS

1. A convex lens
2. A retort stand
3. A plane mirror
4. A pin
5. A plum line

THEORY

A light ray incident on the convex lens, that reflection from the lens becomes the parallel to the principal axis and focus lying on a plane mirror. After then the reflection get back to the same path from the plane mirror and the on reflection through the again, they backtrack their path to from the inverted image of the pinion the object pin itself. The separation of the object pin from the arched convex lens then is equivalent to the focal length of the raised focal point.

PROCEDURE

1. Find the approximate focal length of given convex lens by focusing distant object on the screen and measure the distance between lens and screen which is approximate focal length of convex lens f.
2. Set a plane mirror on the horizontal surface with its reflecting surface upwards.

3. Set the convex lens on the plane mirror.
4. The clamp of retort stands and holds it horizontally above the lens at distance equal to its approximate focal length of convex lens.
5. Bring the tip of pin at the vertical principal axis of the lens so that tip of pin appears touching the tips of its image.

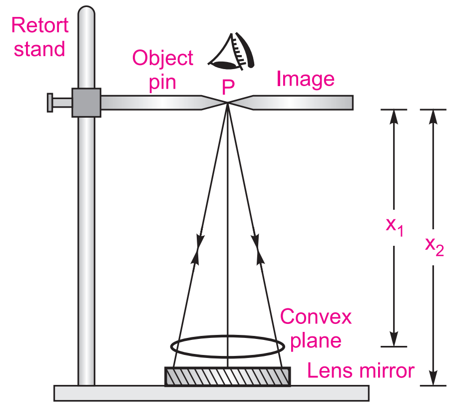


Fig. 8.1

6. Move the index pin up and down and remove the parallax between tips of the index pin and its image.
7. Measure the distance x_1 between tip of pin and upper surface of lens by half meter scale.
8. Also measure the distance x_2 between tip of pin and surface of the plane mirror by removing the convex lens.
9. By using formula, $f = (x_1 + x_2)/2$, find the focal length of given convex lens.

OBSERVATION

1. Range of meter scale .... cm.
2. Least count of meter scale .... cm.
3. Mean value of f = ... cm.
4. Mean value of correct up to 3 *s. f.* = ... cm.

S. No.	x_1	x_2	$f = (x_1 + x_2)/2$
1.			
2.			
3.			
4.			
5.			

RESULT

Focal length of the given convex lens = ... cm.

PRECAUTIONS

1. The tip of the pin should lie on the principal axis of concave mirror.
2. The tip of pin, centre of mirror and centre of lens should be at the same height.
3. While removing the parallax, the eye should be kept at a minimum distance of 30 cm from the index pin.
4. Parallax should be removed between index pin and image of index pin.
5. The liquid should be clean and transparent.
6. The index pin should be clamped horizontally.

VIVA-VOCE

Q. 1. Define the term focus of a convex lens.

Ans. Focus of a convex lens is the point on its principal axis at which the incident rays parallel to the principal axis, after refraction through the lens converge.

Q. 2. Define focal length of a convex lens.

Ans. The distance of focus from the optical centre of a convex lens is called its focal length.

Q. 3. How is a light ray incident from focus of a convex lens refracted through it?

Ans. A light ray from focus of a convex lens after refraction through it becomes parallel to the principal axis.

Q. 4. What is the purpose of plane mirror in your experiment?

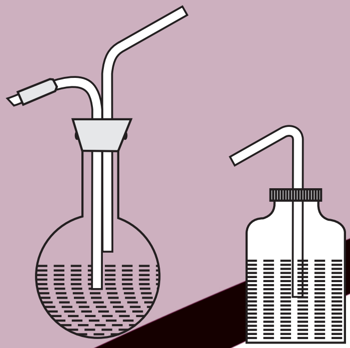
Ans. To reflect back the light rays incident normally on it, along the same path.

Q. 5. What is the position of pin with respect to the lens when there is no parallax between the pin and its image?

Ans. The pin is at the focus of convex lens.

Q. 6. Why do you measure the vertical distance of the pin two times in your experiment?

Ans. To avoid the error arising due to the thickness of lens.



9
CHAPTER

Focal Length of a Convex Lens by One Pin Method

EXPERIMENT 9.1

AIM OF EXPERIMENT

To determine the focal length of a convex lens by one pin method removing parallax.

REQUIRED APPARATUS

1. Optical bench
2. Plane mirror
3. Object pin
4. Meter scale and holders

THEORY

When an object takes at the focus on convex lens, their light ray's incident to object on the lens after the light reflection, take place parallel to the principal axis. If the refracted rays going on normally to plane mirror, the mirror lens reflected back to the same way and retrace the path from the image on the object itself. The distance between object and convex lens gives the focal length.

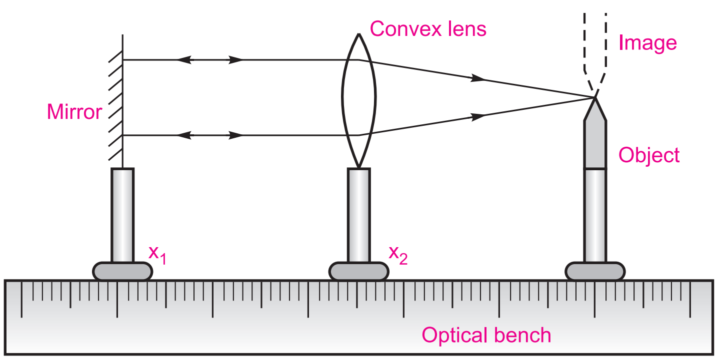


Fig. 9.1

PROCEDURE

1. Set the plane mirror, convex lens and object pin with help of holder on the optical bench as shown in the figure and align them properly with the help of a meter scale.
2. Fix the position of the plane mirror at one end of the optical bench.
3. Now put the convex lens at 20 cm distance from the plane mirror and locate the position of image behind the convex lens in a way to have no parallax between the image and object pin.
4. Write down the position of the plane mirror, convex lens and the object pin. Keep the distance between the plane mirror and convex lens as 30 cm, 40 cm for other set of the readings.
5. The distance between the convex lens and object pin is the focal length of the convex lens.
6. Write down the position of both stand x_1 and x_2 cm, we can find the focal length of lens by distance of the pins from the lens $f = x_1 \sim x_2$.

OBSERVATION

S. No.	*Position of lens x_1 cm*	*Position of lens x_2 cm*	*Focal length $f = x_1 \sim x_2$*
1.			
2.			
3.			
4.			
5.			

1. Value of one division on optical = ... cm.
2. Mean value of f = ... cm.
3. Mean value of up to 3 *s. f.* = ... cm.

RESULT

The focal length of the convex lens f = ... cm.

PRECAUTIONS

1. The plane mirror, convex lens and object should be aligned properly.
2. Parallax has to be removed between object and image before taking the reading.
3. Midpoint of the mirror, optical centre of the convex lens and the top of the object pin should be at the same vertical height.

VIVA–VOCE

Q. 1. What is the position of pin with respect to the lens when there is no parallax between the pin and its inverted image in your experiment?

Ans. The pin is at the focus of the convex lens.

Q. 2. How is the position of pin affected in your experiment if you move the plane mirror away from the convex lens?

Ans. The position of pin remains unaffected.

Q. 3. Is the image real or virtual?

Ans. The image is real.

Q. 4. What is the type of lens is the eye lens?

Ans. An eye lens is a double complex lens mode of proteins.

10

CHAPTER

Focal Length of Convex Lens Using U-V Method

EXPERIMENT 10.1

AIM

To find the focal length of convex lens using u-v method and the formula $f = \dfrac{uv}{u+v}$

REQUIRED APPARATUS

1. Optical bench
2. Screen and object
3. White screen and illuminated object

THEORY

We know that the rules of convex lens, when a real object putted between F and 2F, the inverted and same imaginary image of object beyond by 2F. If we measure image and object distance between focal length.

v = Image distance,

u = Object distance,

f = Focal length,

We know,

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

or,

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

Focal length, $f = \dfrac{uv}{u+v}$ (sign conversion must be used).

PROCEDURE

1. Set the lens, object and screen on the optical bench such as the lens is in between the screen and object.
2. The height of object is adjusted, screen and lens in such that lens object frame, center of the lens and screen on the same level.

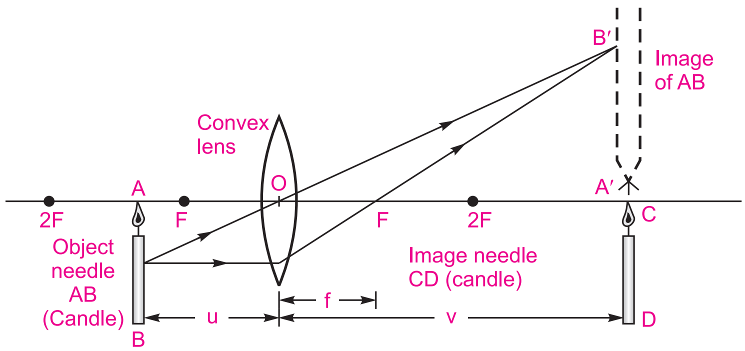


Fig. 10.1

3. The illustrated object is focus on the screen and set the position of the screen through to and fro move moment along with optical bench, that a clear image of the object is denoted on the screen.
4. After we get clear image of object then measure the distance v between the screens. Takes also the imaginary image distance u between the screens.
5. After then we repeat the experiment in different position of the object and read the values for u and v.
6. Find the focal length f of the convex lens using lens formula.
7. Rules of sign conversion u is –ve and v is +ve.

OBSERVATION

S. No.	*Object distance (u) cm*	*Image distance (v) cm*	$f = \dfrac{uv}{u+v}$
1.			
2.			
3.			
4.			
5.			

PRECAUTIONS

1. Choose a dark room for the experiment so the bright image will be appears clearly on the screen.
2. You should be care of object frame like candle and the center of the screen must be equal height.

VIVA-VOCE

Q. 1. How do you estimate the approximate focal length of a convex lens?

Ans. By focusing the light rays from a distant lighted object on a sheet of paper and then measuring the distance of sheet of paper from the lens. This distance gives the approximate focal length of a convex lens.

Q. 2. What should be the position of the object relative to the convex lens so that its real image is obtained?

Ans. The object must lie beyond the focus of the convex lens.

Q. 3. How are the object distance *u*, image distance *v* and focal length of a convex lens related for a real image?

Ans. $\frac{1}{v} - \left(\frac{1}{-u}\right) = \frac{1}{f}$ or $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$ or $f = \frac{uv}{(u+v)}$.

Q. 4. Is the image formed by a convex lens always real?

Ans. No.

Q. 5. When is the image formed by a convex lens virtual?

Ans. The image formed by a convex lens is virtual when the object lies between the optical centre and focus of the lens.

Q. 6. Is the image formed in your experiment magnified or diminished?

Ans. The image formed is magnified so long as the object lies between f and $2f$. The image becomes diminished when the object lies beyond $2f$.

Q. 7. Define power of a lens.

Ans. It is the power of a lens is its ability to bend the rays of light incident on it. It is measured by the reciprocal of its focal length expressed in metres.

Q. 8. Define a diopter.

Ans. It is the power of a lens whose focal length is 1 metre.

Q. 9. An optician prescribed a convex lens of power + 2D to a person. What is the date of the eye from which he is suffering?

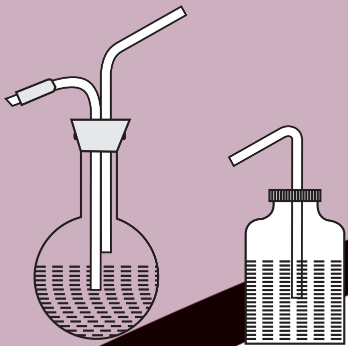
Ans. Hypermetropia or long sightedness.

Q. 10. What is the focal length of a combination of two convex lenses of power 3.5D and 0.5D?

Ans. Power P of the combination = $P_1 + P_2$ = 3.5 + 0.5 = 4D

For length of the combination

$$F = \frac{100}{4} = 25 \text{ cm.}$$



UNIT 7

11

CHAPTER

Refraction of Light Rays through a Prism

EXPERIMENT 11.1

AIM OF EXPERIMENT

To measure the angle of incidence i_1, angle of emergence i_2, angle of deviation δ and angle of prism A and to verify $i_1 + i_2 = A + \delta$. To find the refractive index of the material of prism.

REQUIRED APPARATUS

1. Drawing board
2. Pins
3. Sheet of paper
4. A board pin and triangular equilateral prism.

THEORY

A ray of light after reflect that are produce two face of prism as shown in figure below. A ray of light after incident that made an angle i_1 on the face of AB of the prism reflected along N′N and another made the angle i_2 on the face AC of the prism reflection along N′Q. Where, N′Q is the emergent ray and i_2 equal to '*e*' shown in figure is said the angle of the emergent. The angle lies between the incident and emergent ray is said the angle of derivation.

The angle derivation values are depend on following:

1. The angle of incidence, *i*.
2. The material of the prism
3. The color or wavelength of the light
4. The angle of the prism, A is an angle generally made 60°.

Some, angle of incidence, angle of derivation and δ is minimum. That types of position is called the position of minimum derivation of prism with the incident ray.

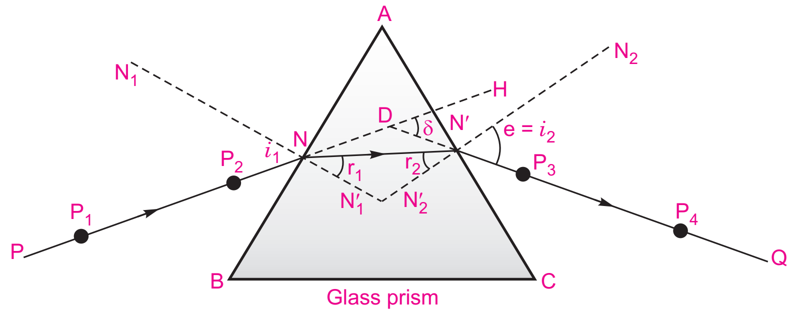


Fig. 11.1

According to the above figure, as a triangular prism.

Angle of incident (i_1) + angle of emergence (i_2) = angle of prism A + angle of derivation (δ),

$$i_1 + i_2 = A + \delta.$$

PROCEDURE

1. Take a drawing board and fix a white sheet of paper on it with the help of drawing pins.
2. Place the prism in the centre of the white paper and draw its outline as ABC.
3. Now, remove the prism.
4. Measure and record the value of angle A.
5. Mark a point N on face AB and draw a normal line N_1N_1'.
6. Draw a line PN such that $\angle PN\,N_1 = 60°$ and fix two pins P_1 and P_2 on PN (approx. 10 cm apart)
7. Now, replace the prism and look through the face AC.
8. Fix two more pins P_3 and P_4 so that all the four lie on the same straight line.
9. Now, remove the four pins one by one and draw small circles around the pin points.
10. Now, join P_1P_2 and P_3P_4, and produce them to meet at N and N′ respectively.
11. At points N′ on face AC, draw a normal line N_2N_2'.
12. Join N and N′.
13. Further extend P_1P_2 and P_3P_4 to meet at D where the angle of deviation is made.
14. Repeat the procedure for different angles $\angle i$ = 30°, 40° and 50°.

OBSERVATION

S. No.	*Angle of incidence i_1*	*Angle of emergence i_2*	*Angle of derivation*	$i_1 + i_2$	$A + \delta$
1.	40				
2.	50				
3.	60				
4.	70				

GRAPH

Plot a graph on the angle of incidence i_1 (on X-axis) and angle of emergence i_2 (on Y-axis).

Both the curves meet at point P. Read the value of i_1 corresponding to the point P and record this value i.

i = ...

Use sine table to find and record the value of sin i and sin $\frac{A}{2}$.

sin i = ...

sin $\frac{A}{2}$ = ...

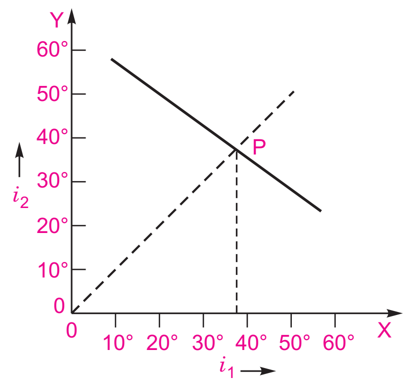


Fig. 11.2

CONCLUSION

The experiment is verified that $i_1 + i_2 = A + \delta$ with experimental error.

PRECAUTIONS

1. In the experiment the prism should not be disturb until the read.
2. Set the perfect position of the pins on the sheet paper and mark clearly the positions of pins.
3. Arrow heads should be marked on the direction of light rays.
4. All set the apparatus the star your experiment.

VIVA-VOCE

Q. 1. How does a ray of light bend after refraction through a prism?

Ans. A ray of light suffers refraction from air to glass at the first face of the prism so it bends towards the normal and then it suffers refraction from glass to air at the second face of the prism and so it bends away from the normal. Thus the incident ray bends towards the base of the prism on suffering refraction through it.

Q. 2. What do you mean by the angle of deviation?

Ans. The angle between the incident ray and the emergent ray is called the angle of deviation.

Q. 3. Name the factors on which the angle of deviation produced by a prism depends.

Ans. Angle of deviation produced by a prism depends on the following four factors: (1) angle of prism, (2) angle of incidence, (3) material of prism, and (4) color of light.

Q. 4. How does the angle of deviation produced by a prism depend on the angle of incidence?

Ans. With increase in angle of incidence, the angle of deviation first decreases, becomes minimum at a certain angle of incidence and then again increases with further increase in angle of incidence.

Q. 5. When is the angle of deviation produced by an equilateral prism minimum?

Ans. For a certain angle of incidence, the refracted ray is parallel to the base of prism. Under this condition, the angle of deviation produced by the prism is minimum. In this condition, angle of incidence is equal to the angle of emergence.

Q. 6. How does the angle of deviation vary with the angle of incidence?

Ans. As the angle of incidence increases, the angle of deviation decreases till it reaches a certain minimum angle (8 m). On further increasing the angle of incidence, the angle of deviation also increases.

Q. 7. How does a ray of light bend after refraction in the prism?

Ans. A ray of light suffering refraction at the two inclined faces is bent towards the base of the prism.

Q. 8. What difference can you detect between the direction of the emergent ray in a glass slab and a prism? Why?

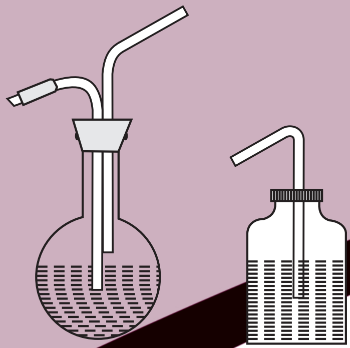
Ans. In a glass slab, the emergent ray is laterally displaced but it is parallel to the incident ray. In the case of a prism, the emergent ray is deviated. This is because, in a glass slab, the two refracting faces are parallel to each other, while in a prism, they are inclined at an angle (A).

Q. 9. Define the angle of minimum deviation.

Ans. In a prism, for a certain angle of incidence, the angle of deviation is minimum. This is called the position of minimum deviation.

Q. 10. On what factors does the angle of deviation depend?

Ans. The angle of deviation depends on: (*i*) Angle of incidence, (*ii*) Angle of prism, (*iii*) The material of the prism, (*iv*) Wavelength of light ray.



12
CHAPTER

Refraction of Light Rays Through a Prism and Measure Angle δ

EXPERIMENT 12.1

AIM OF EXPERIMENT

To trace the path of ray incident normally one face of a (*a*) 60°, 60°, 60° prism (*b*) 45°, 90°, 45° prism, and (*c*) 30°, 90°, 60° prism and hence to measure the angle of deviation in each case.

REQUIRED APPARATUS

1. A drawing board
2. Three prism (one equilateral, one right angle, refracting angle)
3. White sheet of paper
4. Protector
5. Board pins
6. Pins

THEORY

When a light ray incident normally on the surface of an apparent medium gets refracted in the medium without deviation, there for a glass-air interface is make the critical angle is 42°. The incidence angle on the glass to air is greater than 42° then it undergo total internal reflection, when angle of incidence is less than 42°, then it undergo from glass to air and bending away from the normal.

PROCEDURE

1. Take a drawing board and fix the white sheet of paper on the board with help of pins.
2. Take an equilateral prism and sketch the outline ABC on the board, where the equilateral prisms angle (60°, 60° and 60°).
3. After sketch the outline remove the equilateral prism. Take a point X on the AB line there we can see AX is $\frac{1}{3}$ rd of AB.

4. Draw a line XY with X on the line AB and redraw the boundary line ABC on the prism.
5. P and Q are two pins are separation between 5 cm to each other on the line XY and BC is the opposite side from the prism, and other two pins R and S is appear to be in line with the pins P and Q. After this remove the pins and mark the point to the pencil and also remove prism on drawing board.
6. Pins R and S make a line together and produce it to meet the boundary AC of the prism at the point Z.
7. According to the figure measure the angle $x = \angle XZS$, write down a note, the angle of deviation $\delta = 180° - x$. You will determine $\delta = 60°$.
8. Do the same experiment several times with different angles of prism (45°, 90°, 45°, right angled prism.). According to figure, you will determine $\delta = 90°$.
9. Do the same experiment several times with different angles of prism (30°, 90°, 60°, right angled prism.). According to figure, you will determine $\delta = 41°$.

OBSERVATION

1. For the equilateral angles of the prism (60°, 60° and 60°).

   According to the figure,

   $$x = \text{...........}\ °,$$

   Angle of deviation $\delta = 108° - x =$ .... °.
2. For the right angles of the prism (45°, 90° and 45°).

   According to the figure,

   $$x = \text{...........}\ °,$$

   Angle of deviation $\delta = 108° - x =$ ....°.
3. For angles of the prism (30°, 90° and 60°).

   According to the figure,

   $$x = \text{...........}\ °,$$

   Angle of deviation $\delta = 108° - x =$ .... °.

RESULT AND EXPLANATION

1. According to the figure, for the equilateral prism

- When the ray PQ also incident normally on the face AB of the prism passes undeviated as ZQ in to the prism and it heat the face of AC of the prism at an angle of incidence 60° at point Z.
- A light ray total internal reflection at the glass to air interface, there the angle of incidence is greater than the critical angle, where the angle 42°.
- A ray going through the ZZ′ there total internal reflections keep normally on the face of BC of the prism.
- RS is the emergence ray that turn through an angle 60° with the incident ray PQ.

2. According to the figure, for the right angle prism

- When the ray of light PQ in incident of normally at the face AB and its passes un deviate as QZ in the prism and heat as the face AC of the prism at an angle of incidence is equal to 45°. Whereas glass interface, the critical angle 42°.

- The ray light of QZ total internal reflection, because the incidence angle is greater than critical angle.
- The incident ray gets deviated through 900 when the passing through the prism.

3. According to the figure, for the prism (30°, 90° and 60°).

- When the ray of light PQ in incident of normally at the face AB (opposite to 30° reflecting angle) and its passes un deviate as QQ into the prism and heat as the face AC of the prism at an angle of incidence is greater to 60° at the point Q′. Whereas glass interface, the critical angle 42°.
- The ray light of QZ total internal reflection, because the incidence angle is greater than critical angle.
- The incident ray gets deviated through 30° when the passing through the prism.
- If the angle of incidence at glass to air interface is less than the critical angle so that the ray Q′Z from the glass to air is greater than 30°.

PRECAUTIONS

1. Two pins P and Q should be 5 cm far to each other.
2. All the pins should be in Vertical position.

VIVA-VOCE

Q. 1. What is a totally reflecting prism?

Ans. It is a prism which turns the path of a ray of light through a certain angle by total internal reflection.

Q. 2. Where are such prisms used?

Ans. (*i*) In Binocular

(*ii*) In Periscope.

Q. 3. When the prism is set in the minimum deviation position, how does the refracted ray pass through the prism?

Ans. The refracted ray passing through the prism is parallel to the base of the prism.

Q. 4. If the angle of the prism is 60° and it is set in the minimum deviation position, what is the angle of refraction?

Ans. We know that $A = r_1 + r_2$ and in the minimum deviation position $r_1 = r_2 = r$ (say),

$$A = r + r = 2r \text{ or } r = \frac{A}{2} = 30°.$$

Q. 5. How do you define critical angle?

Ans. It is defined as the angle of incidence in the denser medium for which the angle of refraction in the rarer medium is 90°.

Q. 6. What is the relation between refractive index and the angle of minimum deviation produced by a prism?

Ans. $\mu = \dfrac{\dfrac{\sin(A+2)}{2}}{\sin(A/2)}$.

Q. 7. Where are totally reflecting prisms used?

Ans. They are used in turning the path of a ray of light through (*i*) 90° (*ii*) 180°.

Q. 8. What is dispersion of light?

Ans. Splitting up of white light into its constituent colours when it is incident on a prism is called dispersion.

Q. 9. How is the critical angle related to the refractive index?

Ans. $\mu = \dfrac{1}{\sin C}$.

Q. 10. What is the range of wavelength of visible light?

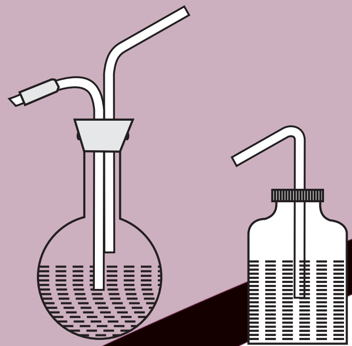
Ans. 4000 A – 8000 A.

Q. 11. What is the ratio of the speed of the light of violet colours and green colours of light in vacuum?

Ans. 1 : 1, because speed of both colours of light of violet colours in vacuum is same.

Q. 12. A ray of light is incident at the critical angle 42°, when going from glass to air, what is the angle through which this ray is deviated?

Ans. $90° - 42° = 48°$.



UNIT 8

13 CHAPTER

Heat Transfer

EXPERIMENT 13.1

AIM OF EXPERIMENT

To determine the specific heat capacity of the material of a given calorimeter.

REQUIRED APPARATUS

1. A calorimeter
2. Thermometer
3. Measuring cylinder
4. A glass rod
5. Tap water and boiling water.

THEORY

According to principal of mixture, when the hot water is mixed with the cold water in a calorimeter, their some heat losses by the hot water and cold water and calorimeter gain the heat. If no heat losses then we use the principal of mixture method.

Heat lost by the hot water = heat gain by calorimeter + heat gain by the cold water.

We, assume that the volume of calorimeter V_1 cm^3 and the mass of the calorimeter is mg, temperature of cold water t_1°C. Density of water is equal to 1 g cm^{-3}.

The mass of cold water at temperature t_1°C will be V_2 cm^{-3} of hot water at temperature t_3°C is mixed with it.

By the principal of mixer, Final steady temperature of mixture, t_3°C

Heat lost by the hot water= $V_2 \times 1 \times (t_2 - t_1)$ Cal

Heat gain by the calorimeter = $m \times S \times (t_3 - t_1)$ Cal

Heat lost by the cold water= $V_2 \times 1 \times (t_3 - t_1)$ Cal

Where,

S = specific heat capacity

If no heat required there,

$$V_2\ (t_2 - t_3) = V_2\ (t_2 - t_3) + V_1\ (t_3 - t_1)$$

Therefore heat capacity of material of calorimeter $s = \left\{\dfrac{V_2\ (t_2 - t_3)}{m\ (t_3 - t_1)} - \dfrac{V_1}{m}\right\}$ Cal $g^{-1 0}C^{-1}$

PROCEDURE

1. Write down the record of calorimeter mass and thermometer reading.
2. Measure volume V_1 of the tap water (approximate 100 cm^3) through a measuring cylinder.
3. Read the temperature of thermometer t_1°C.
4. Write down the temperature of cooling water t_2°C through the thermometer and measure the volume of cooling water V_2 (approximate 50 cm^3).
5. Read the temperature of thermometer t_2°C.
6. Mix well the substance of calorimeter with a glass bar till the final steady temperature t_3°C came to.

OBSERVATION

1. Least count of thermometer = ... °C
2. Mass of colorimeter m = ... g
3. Volume of tap water V_1 = ... cm^3
4. Temperature of tap water t_1 = ... °C
5. Temperature of boiling water t_2 = ... °C
6. Volume of boiling water volume V_2 = ... cm^3
7. Final steady temperature of mixture t_3 = ... °C

CALCULATION

Determine the specific heat capacity of the material of the calorimeter.

$$S = \left\{\frac{V_2\ (t_2 - t_3)}{m\ (t_3 - t_1)} - \frac{V_1}{m}\right\} = \text{..} \text{ Cal } g^{-1 0}C^{-1}$$

PRECAUTIONS

1. Note the every time temperature when the steady.
2. Mix boiling water in the beaker, should be care the water does not splash.
3. Boiling water should me fast mix with the calorimeter, there should not be losses heat in air.

VIVA-VOCE

Q. 1. What is a calorimeter?

Ans. Calorimeter is a vessel in which two liquids (or one liquid and one solid) at different temperatures are mixed to find the heat lost by the body at high temperature and the heat gained by the body at low temperature.

Q. 2. Name the material of which a calorimeter is made up of.

Ans. It is made up of copper because the specific heat capacity of copper is low.

Q. 3. What are the main requisites of a calorimeter?

Ans. 1. It must have a low heat capacity, so it is made of thin copper sheet.

2. Its inner and outer surfaces are polished to reduce the loss of heat due to radiation.
3. It is covered with wool, cotton etc., and is placed inside a wooden jacket to avoid the loss of heat by conduction.
4. It is covered with a wooden lid to avoid the loss of heat by convection.

Q. 4. Fine the term specific heat capacity.

Ans. Specific heat capacity of a substance is the quantity of heat required to raise the temperature of unit mass of that substance by 1°C.

Q. 5. What is the specific heat capacity of copper?

Ans. Nearly 0.1 cal $g^{-1}{}^{\circ}C^{-1}$ (or 0.4 J $g^{-1}{}^{\circ}C^{-1}$).

Q. 6. State the S.I. unit of specific heat capacity.

Ans. J kg^{-1} K^{-1}.

Q. 7. What is the principle of heat?

Ans. According to this principle when a hot body is mixed or is in contact with a cold body. Transfer of heat energy takes place from the hot body to the cold body till both acquire the same temperature. If the system is thoroughly insulated, then Heat energy lost by the hot body = Heat energy gained by the cold body.

Q. 8. What determines the direction of flow of heat-Quantity of heat or temperature?

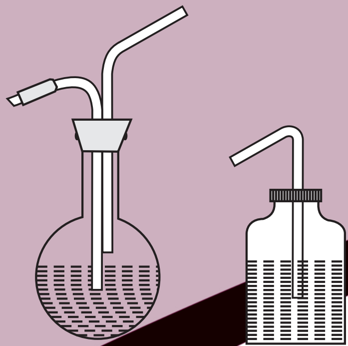
Ans. Temperature determines the direction of flow of heat. Heat always flows from a body at a higher temperature to the body at a low temperature.

Q. 9. Define thermal or heat capacity of a body.

Ans. Thermal capacity of a body is defined as the amount of heat required to raise the temperature of the body through 1°C.

Q. 10. What is the SI unit of heat capacity?

Ans. JK^{-1}.



14

CHAPTER

Heat Transfer of Metal by Method of Mixture

EXPERIMENT 14.1

AIM

To determine the specific heat of a metal by the method of mixture.

REQUIRED APPARATUS

1. Solid (*e.g.*, metal) of reasonable size
2. Calorimeter with an insulation, outer jacket and stirrer
3. Thermometer (reading up to 0.1°C)
4. Heater
5. Thread
6. Sensitive balance
7. Beaker

THEORY

The specific heat capacity C of an object (*i.e.*, metal) is the proportionality constant between an amount of heat and the change in temperature that the heat produced in the object.

Thus, $Q = C\,(t_i - t_f)$,

where, t_i = Initial temperature of the object

t_f = final temperatures of the object

Two objects made of the same material, say dust, will have heat capacities proportional to their masses. It is therefore convenient to define a heat capacity per unit mass or specific heat c that refers not to an object but to unit mass of the material of which the object is made and is expressed in joule per kilogram per Kelvin (J $kg^{-1}K^{-1}$).

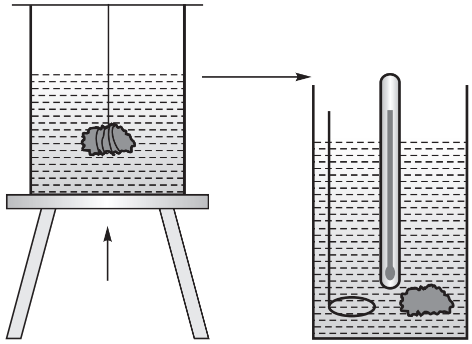


Fig. 14.1

The specific heat capacity equation then becomes Q = mc ($T_f - T_i$), where m is the mass of the object.

Let t is final temperature of the mixture of metal and c is specific heat, w is water equivalent of the calorimeter.

Heat gained of water and calorimeter = $(m + w)(t - t_f)$

According to principal of heat,

Heat lost = Heat gained

$$Mc\,(t - t_i) = (m + w)(t - t_f)$$

$$C = \frac{(m + w)(t - t_f)}{m\,(t - t_i)}$$

PROCEDURE

1. You will work on individual basis. However, if the apparatus are not enough, then you will work in small groups.
2. You should set up the experiment as shown in the diagram above.
3. Weigh the metal ball and record its mass.
4. You should suspend the metal ball in water contained in a beaker.
5. You should heat the beaker with the water until it boils for about 15 minutes.
6. While heating the solid, weigh the calorimeter empty, and record the mass.
7. Weigh the calorimeter again when two-thirds full of water, and record the mass.
8. Take the temperature of the water in the calorimeter placed in its outer jacket.
9. When the solid has been in the boiling water for about 15 minutes, you should remove it gently, hold it briefly in the steam above the water and quickly transfer it into the water in the calorimeter.
10. You should stir continuously and record the final temperature of the mixture.
11. Record your observations and calculate the specific heat capacity of the metal ball.

OBSERVATION

Record your observations as follows:

1. Mass of metal m_1 = ...
2. Mass of empty calorimeter m_2 = ...
3. Mass of calorimeter + water m_3 = ...

4. Initial temperature of water in calorimeter T_i = ...
5. Temperature of the hot solid 100°C = ...
6. Temperature of mixture T_f = ...
7. Rise in temperature of water and calorimeter $(T_f - T_i)$°C = ...
8. Fall in temperature of hot metal $(100 - T_i)$°C = ...
9. Calculate the specific heat capacity c of the solid as show below:
   Let S.H.C of solid = c

Also, let S.H.C of calorimeter $= c_1$

And let S.H.C of water $= c_w$

Heat lost by solid $= m_1 c\,(100 - T_f)$

Heat gained by water $= (m_3 - m_2)\, c_w (T_f - T_i)$

Heat gained by calorimeter $= m_2\, c_1\, (T_f - T_i)$

Total heat gained $= (T_f - T_i)\, [(m_3 - m_2)\, c_w + m_2\, c_1]$

But heat lost = Heat gained

$$m_1 c\,(100 - T_f) = (T_f - T_i)\,[(m_3 - m_2)\, c_w + m_2\, c_1]$$

$$c = \frac{(T_f - T_i)[(m_3 - m_2)\, c_w + m_2 c_1]}{m_1(100 - T_f)}$$

PRECAUTIONS

1. The metal should be dust form.
2. The metal not to be impurity.
3. The mixture should be stirred well but gently.
4. Water not to be filled full in calorimeter.
5. Half degree thermometer should be used.
6. Temperature correction should be applied.

VIVA-VOCE

Q. 1. What is specific heat?

Ans. Specific heat of a substance is the amount of heat required to raise the temperature of unit mass of that substance by unity.

Q. 2. What is the SI unit of specific heat?

Ans. The SI unit of specific heat is J kg^{-1} K^{-1}.

Q. 3. What is CGS unit of specific heat?

Ans. Cal g^{-10} C^{-1}.

Q. 4. Define one calorie.

Ans. One calorie is the amount of heat required to raise the temperature of 1 g of water from 14.5°C to 15.5°C.

Q. 5. How many joules are there in one calorie?

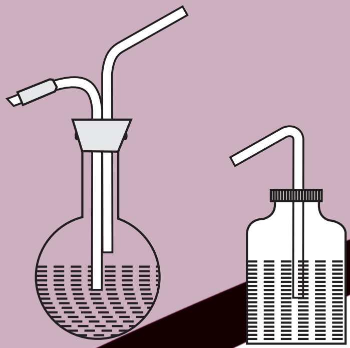
Ans. 1 cal = 4.185 J.

Q. 6. What is calorimeter?

Ans. Calorimeter deals with the measurement of heat.

Q. 7. Why is calorimeter made of copper?

Ans. Because copper is a very good conductor of heat and has a low specific heat.



15

CHAPTER

Specific Latent Heat of Ice

EXPERIMENT 15.1

AIM OF EXPERIMENT

To determine the specific latent heat of ice.

REQUIRED APPARATUS

1. A glass beaker
2. Tap water
3. Small pieces of ice
4. Boiling paper
5. A cylinder
6. Thermometer.

THEORY

According to the principal of mixture, when ice is mixed with water in a beaker, the water and beaker losses heat, the ice is the amount of heat required to change of ice to water without a change in temperature.

By the principal of mixture,

Heat gain by ice = Heat loss by beaker + Heat lost by water.

Let, volume of water V_1 cm^3 is taken in a beaker of mass m g at initial temperature t_1 °C. If we assume that the final temperature of mixture become t_2 °C and final volume of water when all ice has melted v_2 cm^3.

Added the mass of ice $= (V_1 - V_2)\, g$

Temperature of beaker $= (t_1 - t_2)$ °C

Melted ice temperature $= t_2$ °C

According to the specific heat capacity,

Specific heat capacity of water to be 1 cal g^{-10} C^{-1}

Specific heat capacity of melted beaker to be s cal g^{-10} C^{-1}

Specific heat capacity of ice to be L cal g^{-10} C^{-1}

Heat gain by ice = $(V_2 - V_1)$ L + $(V_1 - V_2) \times 1 \times t_2$ cal.

Heat lost by water = $V_1 \times 1 \times (t_1 - t_2)$ cal.

Heat lost by beaker = $m \times S \times (t_1 - t_2)$ cal.

By the principal of mixture,

$(V_2 - V_1)\,L + (V_2 - V_1)\,t_2 = V_1\,(t_1 - t_2) + ms\,(t_1 - t_2)$

We are you assuming ms to be negligible

$(V_2 - V_1)\,L + (V_2 - V_1)\,t_2 = V_1\,(t_1 - t_2) + (t_1 - t_2)$

Specific latent heat of ice,

$$L = \{V_1/(V_2 - V_1)\}(t_1 - t_2) - t_2 \text{ cal } g^{-1}$$

$$= (V_1\,p/M) - t_2 \text{ cal g}^{-1}$$

where, P = fall in temperature of water = $(t_1 - t_2)$ C^0

M = mass of ice = $(V_2 - V_1)$ g.

PROCEDURE

1. Note the record of least count of thermometer.
2. Measuring the volume of water V_1 by the measuring cylinder and pour into the glass beaker.
3. Note the temperature t_1°C of water with the thermometer and record the v_1 and t_1.
4. Take some quantities of dry the small pieces of ice with the blotting paper also mixed the water in contained in beaker, note the final temperature t_2°C.
5. Record the empty beaker and measuring cylinder and note the final volume V_2.
6. Determine the mass of ice M = $(V_2 - V_1)$ g and the fall in temperature of water $p = (t_1 - t_2)$°C.
7. Determine specific latent heat of ice using the formula L = $(V_1\,p/M) - t_2$ cal g^{-1} correct up to 3 *s. f.*

OBSERVATIONS

1. Least count of temperature = ...°C.
2. Volume of tap water V_1 = ...cm^3.
3. Temperature of tap water t_1 = ...°C.
4. Final study temperature of mixture t_2 = ...°C.
5. Volume of water and melted ice V_2 = ...cm^3.

CALCULATIONS

1. Mass of ice M = $V_2 - V_1$ = ... g.
2. Fall in temperature of mixture t_2 = ...°C.
3. Specific latent heat of ice L = $(V_1\,p/M) - t_2$ = ... Cal g^{-1}

RESULT

Specific latent heat of ice L = $(V_1\,p/M) - t_2$ = ... cal g^{-1}

PRECAUTIONS

1. The water and ice should be dry in beaker.
2. Take care that water does not splash out.
3. Read the final temperature of mixture only, it has become steady.

VIVA-VOCE

Q. 1. What do you mean by specific latent heat?

Ans. Specific latent heat of a substance is the amount of heat required to change the state of unit mass of that substance at constant temperature.

Q. 2. What is specific latent heat of fusion?

Ans. Specific latent heat of fusion of a substance is the amount of heat required to melt the unit mass of that substance at its melting point.

Q. 3. Define the terms (*i*) heat capacity (*ii*) specific heat capacity.

Ans. Heat capacity of a body is defined as the amount of heat required to raise the temperature of the whole body through 1°C whereas specific heat capacity is heat required to heat 1 *g* of the body through 1°C.

Q. 4. Why are latent heat called so?

Ans. The latent heat supplied to the substance does not change the temperature but it is used only to change the state of that substance, so it is called latent heat.

Q. 5. What is the unit of specific latent heat?

Ans. J kg^{-1} in SI and cal g^{-1} in CGS system.

Q. 6. What is the specific latent heat of ice?

Ans. It is 80 cal g^{-1} or 3.35×105 J kg^{-1}.

Q. 7. Why is the calorimeter placed in an insulating jacket?

Ans. So that the heat may not radiate from the surface of the calorimeter.

Q. 8. What is the principle of calorimetry?

Ans. Principle of calorimetry is that heat gained by one substance is equal to the heat lost by the other substance, when they are mixed together provided the heat is not lost to the surroundings by any other way.

Q. 9. Why is water stirred, when ice is put in it?

Ans. Water is a bad conductor of heat. It is stirred by using a stirrer so that its temperature may change uniformly throughout its volume.

Q. 10. Define melting point of a solid.

Ans. The constant temperature at which a solid changes to liquid is called the melting point of the solid.

Q. 11. Are the melting point and freezing point the same?

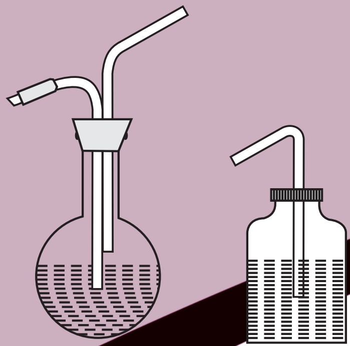
Ans. Yes, both are equal.

Q. 12. Define specific latent heat of vaporization.

Ans. Amount of heat required to convert unit mass of the substance from liquid to vapour state without any change in temperature.

Q. 13. What happens to the energy supplied during change of state?

Ans. During the change of state potential energy of the molecules increases as the distance between them increases. However, kinetic energy remains the same.



UNIT 9

16

CHAPTER

Experiment Based on Electricity

EXPERIMENT 16.1

AIM OF THE EXPERIMENT

To verify ohm's low and hence to determine the resistance of a given conductor wire.

THEORY

According to the Ohm' law,

"Ohm's law states that at a constant temperature, current 'I' through a conductor between two points is directly proportional to the potential difference or voltage 'V', across the two points".

$$V \propto I$$

Or, $\frac{V}{I}$ = Constant = R, the ratio V : I is a constant.

Or, $V = IR$

where, R is proportional constant of resistance of the given wire.

I is the current in ampere

V is the potential difference in voltage

R is the resistance in ohm.

Here, a graph plotting for voltage (V) against the current (I) is the forward straight.

1. Resistance is the property of a component which restricts the flow of electric current.
2. Energy is used up as the voltage across the component drives the current through it and this energy appears as heat in the component.

V_1 = ... Volt

V_2 = ... Volt

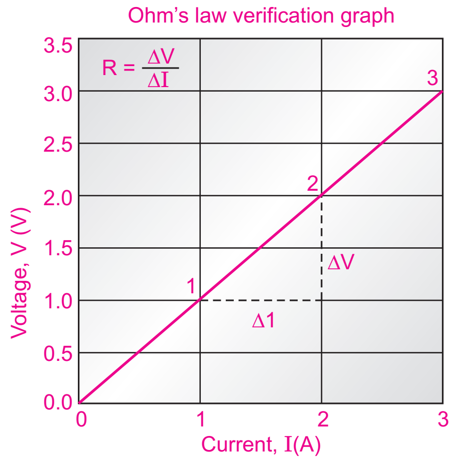


Fig. 16.1

PROCEDURE

1. According to the figure, a battery B placed between two terminals connected with the key K.
2. A is an armature connected with the conductor wire R, after then a rheostat Rh in series with the conductor wire R.
3. +ve terminal in the battery is connected with armature (A), a voltmeter parallel connected with the resister (R) with +ve terminal of the battery on the side of voltmeter (V).
4. Write down the least count of ammeter (A) and voltmeter (V) also read the zero error of the meter.
5. If put the plug into key (K) and set rheostat Rh by the sliding its variable terminal until the current (I) through the armature is 0.8 A also read the voltmeter (V). Remove the plug of key (K) write down the record corrected V after subtracting the zero error of armature (A) from observed current (I). Do similar step 5 for the voltmeter.
6. Do the several times experiment for different Current (I) = 0.7, 0.6 and 0.5 A, if it heated up to its temperature due to no longer constant.
7. Determine each observation correct up to 3 *s*. *f*. and reach the means value of R.

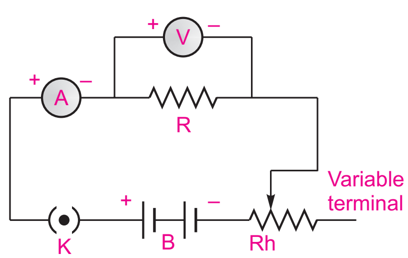


Fig. 16.2

OBSERVATION

S. No.	Ammeter reading (A)		Voltmeter reading (R)		Resistance $R = V/I$
	Observed I	Corrected I	Observed V	Corrected V	
1.					
2.					
3.					
4.					
5.					

1. Least count of the ammeter = ... A.
2. Least count of the Voltmeter = ... V.
3. Zero error of the ammeter = ... A.
4. Zero error of the voltmeter = ... A.
5. Means value of R = ... ohm.

PRECAUTIONS

1. You must be check the all connection with circuit and also check the loose connect on circuit.
2. You should be check current is passing on the circuit or not.
3. Do not try to current longer flow in the wire. If heat the resistance then change the temperature or the wire.
4. You should be check plug inserted on the board or not when the observations are taken.
5. You should check range of voltmeter because must be more than e.m.f. of the battery.

VIVA-VOCE

Q. 1. What is current? Give its unit.

Ans. Rate of flow of charge is called current. S1 unit of current is ampere, (A).

Q. 2. Define potential difference and give its unit.

Ans. The potential difference between any two points is equal to the work done in moving a unit positive charge from one point to the other. Its unit is volt. (V).

Q. 3. What is the relation between V and I?

Ans. V = IR (Ohm's law), where R is the resistance of conductor (in Ohm).

Q. 4. What are the limitations of Ohm's law?

Ans. It is not applicable to non-ohmic resistances such as diode valves, triode valves and transistors.

Q. 5. What is the voltage of the household supply?

Ans. Generally, it is 220 volt.

Q. 6. Does resistance vary with temperature?

Ans. Yes, resistance varies with temperature. It increases with the rise of temperature in most cases.

Q. 7. Can the resistance of a device be – ve?

Ans. Yes, the resistance of a device is – ve, if with the increase in voltage the current decreases.

Q. 8. Two copper wires are of the same length but one is thicker than the other. Which wire will have more resistance?

Ans. The thinner wire has more resistance because the resistance is inversely proportional to the area of cross-section.

Q. 9. In, which wire will have more specific resistance?

Ans. Both the wires have the same specific resistance because specific resistance only depends upon the nature of the material which is copper in both cases.

Q. 10. Does the specific resistance depend upon temperature and dimensions of the conductor?

Ans. The specific resistance depends upon temperature but is in dependant of the dimensions of the wire.

17

CHAPTER

The Model of Household Wiring Circuit

EXPERIMENT 17.1

AIM OF THE EXPERIMENT

To set up a model of household wiring including ring main system and hence to study the junction of switched and fuses.

REQUIRED APPARATUS

1. Switches
2. Wall stokes
3. Electric wires
4. Plugs
5. Bulbs holder
6. Fuses of different rating
7. Screw driver
8. A switch board

THEORY

Electricity leading group of the state is in charge of the electric power supply to the purchaser, and the power is provided through underground cable of overhead wires on the poles. These supply wires are three numbers—Phase wire, unbiased wire and earth wire. Distinctive colours have been given to the protection of these wires as shown in table figure.

There are three types of wire:

1. Live wire (red and brown)
2. Neutral (black and light blue)
3. Earth wire (green and green with yellow).

PROCEDURE

1. The power of appropriation in a house, the three wires can be arranged in the latest system of power distributed, known as ring system.
2. The three wires in the system that name is live wire, neutral wire and earth wire, begin from the fundamental circuit box containing a principle meld around 30 A. The wiring circles the diverse room of the house from a shut and ends in the breaker box once again.

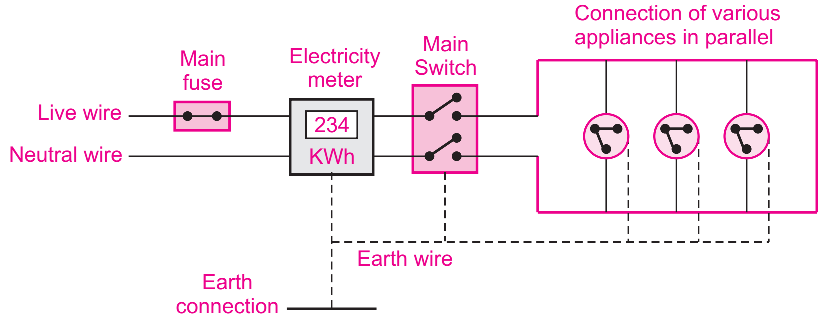


Fig. 17.1

3. All three wire live wire, neutral wire and earth wire is connected in parallel for heavy appliance. This is complete to ensure full voltage from the main appliance. If one appliance is switched off or short circuited or get fused the other appliance are not affected.
4. The electrical appliances are gives with separate connection as like switch to switch ON or OFF the flow current to it. Mostly switches are put in the live wire, to complete cut-off the appliance from the source of current and to safeguard the consumer from the dangerous of electric shock.
5. All separate wires of the house is provides with separate fuse and the fuse all like a small pieces of tin wire (copper, aluminium having high resistance and low melting point), the melting point of the fuse wire is low. At the point when the substantial current goes through the circuit because of the over stacking and short out, along these lines stream of current through the circuit before any harm should be possible to rest of the wiring circuit.

PRECAUTIONS

1. Check the naked wires and covered with help insulating tape.
2. Make all wire connection should be tight.
3. Do not touch wire when the connected with live wire.
4. Put the all switched with live wire.
5. And a good quality fuses wire use in fuse kits.

VIVA-VOCE

Q. 1. What is the colour of insulation on the live wire and neutral wire?

Ans. The colour of insulation on the live wire is red while on the neutral wire is black.

Q. 2. At what voltage does the household electrical appliance such as an electric bulb work?

Ans. At 220 volt.

Q. 3. How do you connect two or more than two appliances in a circuit with the mains: in series or in parallel? Give reason to your answer.

Ans. In parallel. The reason is that in parallel, each appliance works at the same voltage (equal to the voltage of the mains) and the operation of one appliance does not depend on the operation of other appliance.

Q. 4. What is the function of switch in a circuit?

Ans. The function of switch is to on or off the circuit.

Q. 5. In which wire is the switch connected?

Ans. The switch is connected in the live wire, before the appliance is connected.

Q. 6. What is the function of fuse?

Ans. The fuse limits the current in the circuit. If the current in circuit exceeds the maximum current carrying capacity of the fuse wire, it blows off.

Q. 7. In which wire is the fuse connected?

Ans. The fuse is connected in the live wire, before the appliance is connected.