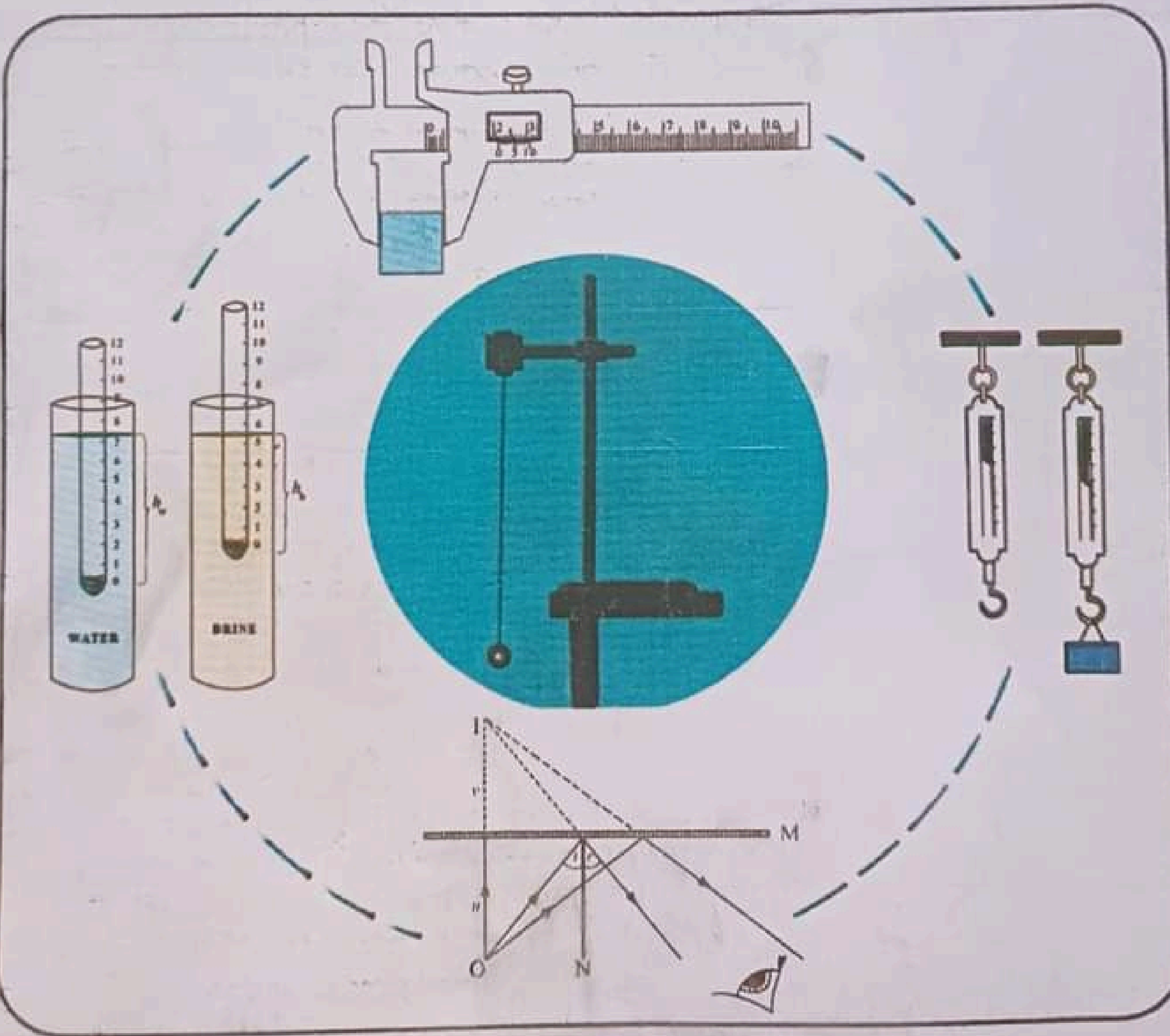
THE GOVERNMENT OF
THE REPUBLIC OF THE UNION OF MYANMAR

MINISTRY OF EDUCATION

PRACTICAL PHYSICS
PHYSICS
GRADE 11



CONTENTS

EXPERIMENT 1

PRINCIPLE OF MOMENTS

Aim of Experiment

- To find the mass of a given body using a metre rule.

Apparatus

Moment bar, metre rule, slotted weights, weight hanger, body (unknown mass), measuring tape, string

Theory

The principle of moments states that if an object such as a bar (or) a plank is to be in balance, the total clockwise moment about the fulcrum must equal the total anticlockwise moment.

Description of apparatus

Moment bar is usually a uniform metre rule, holed and suspended at the centre (centre of gravity). The fulcrum point is taken at the centre of the metre rule. The metre rule is adjusted until to become horizontal. The moment bar works with the principle of moments. If two masses m_1 and m_2 suspended on a metre rule and adjusted until the metre rule becomes horizontal again (see Figure 1), we can write

$$m_1d_1 = m_2d_2 \ .$$

where m_1 is the known mass, m_2 is the unknown mass, d_1 is the distance between the known mass m_1 and the fulcrum, and d_2 is the distance between unknown mass m_2 and the fulcrum.

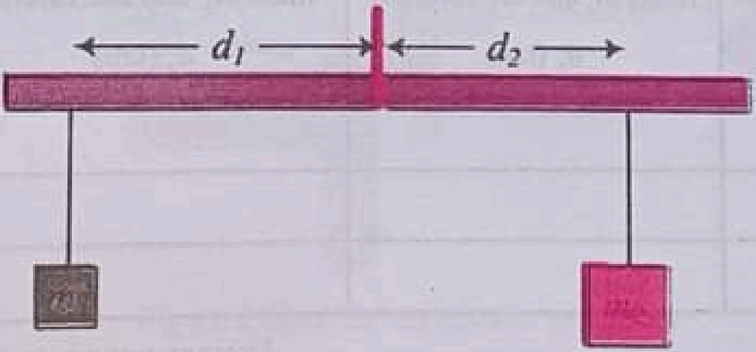


Figure 1 Moment bar

Moment = Force × moment arm

= Force × perpendicular distance from the fulcrum to the line of action of the force

Clockwise moment is equal to anticlockwise moment when the system is in equilibrium.

$$(m_2g)\,d_2 = (m_1g)\,d_1$$

Figure 2 An arrangement of moment bar experiment

Procedure

1. Moment bar is hung to the retort stand as shown in the Figure 2. (If the moment bar is not horizontal, a rubber band should be used as a rider).
2. 100 g weight is hung at 30 cm mark of metre rule. The 50 g weight is hung at 60 cm mark of metre rule. The 50 cm mark is taken as fulcrum. Calculate the clockwise and anticlockwise moments. Verify the principle of moments.
3. 100 g weight is hung at 20 cm, 25 cm, 30 cm mark of metre rule. A stone of unknown mass is hung on the other side of the fulcrum and adjust horizontal position for balance. Determine the mass of the stone using principle of moments.

Reading of the centre of gravity of the metre rule = ________ cm

Sr. No.	mass inserted on the weight hanger m_1 (g)	distance between known mass m_1 and the fulcrum d_1 (cm)	distance between unknown mass m_2 and the fulcrum d_2 (cm)	unknown mass $m_2 = \frac{m_1 d_1}{d_2}$ (g)
1.				
2.				
3.				
			Average unknown mass	

Result

- Mass of the stone = ________ g = ________ kg

Precautions

- Check that moment bar is exactly horizontal.

Discussion

EXPERIMENT 2
HOOKE'S LAW

Aim of Experiment

- To verify the Hooke's Law (The relation between force and extension of a spring).

Apparatus

Hooke's law apparatus, set of known masses (weight box), ruler or metre stick

Theory

When an elastic body such as a spring is stretched by a load (or) a force, the amount of elongation of the spring is proportional to the applied force that produces it as long as the elastic limit is not exceeded. The amount of elongation is also called extension.

Hooke's law is formally stated as follows.

As long as the elastic limit of a body is not exceeded, the strain produced is proportional to stress causing it. In symbols, $F \propto x$ (or) $F = k x$

where F is the applied force (or) stress, x is the extension (or) strain and k is a constant. For a spring, k is also called spring constant. The unit of k is N m^{-1}.

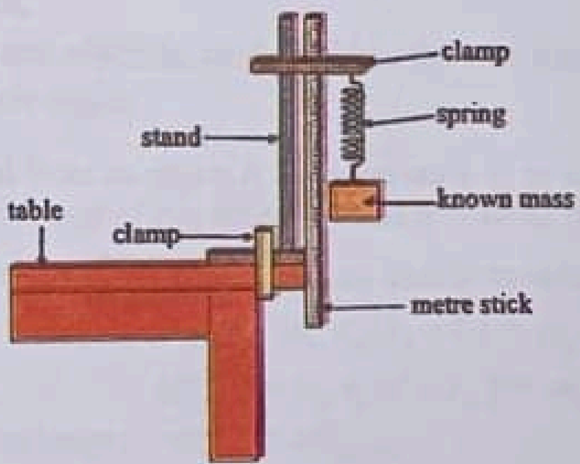


Figure 1 Hooke's experiment apparatus

Procedure

1. Assemble the apparatus as in Figure 1.
2. Measure the length of unstretched spring.
3. Hang a mass m_1 on spring and record the length of the extended spring.
4. Repeat the step 3 for different masses. (m_2, m_3)
5. Calculate the applied force for different masses.
6. Construct a data table and draw a graph of extension versus load.
7. Calculate spring constant k from the slope of graph.

Length of unstretched spring l_0= ________ cm

Sr. No.	mass m (kg)	load $F = mg$ (N)	length of stretched spring l (cm)	extension $x = l - l_0$ (cm)	spring constant $k = \frac{F}{x}$ (N cm^{-1})
				Average spring constant	

Result

- The spring constant k is ________ N cm^{-1}.
- The spring constant k from the slope of graph is ________ N cm^{-1}.

Precautions

- The load must not exceed elastic limit of given spring.

Discussion

EXPERIMENT 3
SPECIFIC HEAT CAPACITY OF COPPER

Aim of Experiment

- To determine the specific heat capacity of copper.

Apparatus

Calorimeter, beaker, thermometer(0 to 100 °C), copper block, bunsen burner, stirrer, balance

Theory

The specific heat capacity of a substance is the heat needed to change the temperature of a unit mass of that substance by one degree.

The specific heat capacity $c = \frac{\Delta Q}{m\,\Delta T}$

where c is specific heat capacity, m is mass of substance and ΔT is temperature change.

If the mass of a substance is m and its specific heat capacity is c, the amount of heat required to raise temperature ΔT is $m\,c\,\Delta T$.

The amount of heat is $\Delta Q = m\,c\,\Delta T$.

where ΔT is the temperature difference between the final and the initial temperature.

The law of heat exchange states,

When heat is transferred from one object to another object the total heat lost by one object is equal to the total heat gained by the other object.

Suppose that heat is transferred from an object A at temperature T_A to another object B at temperature T_B. In this case, the system consisting of two objects A and B must be regarded as an isolated system.

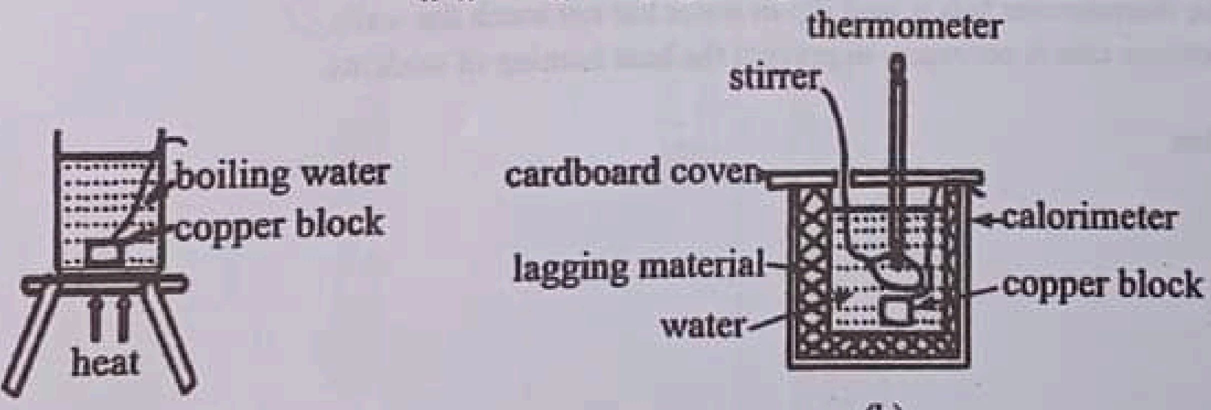
When final temperature T of the objects are the same, no heat is transferred.

Heat lost by object A, $\Delta Q_{\text{lost}} = m_A\,c_A(T_A - T) = m_A\,c_A(\Delta T)_A$

Heat gained by object B, $\Delta Q_{\text{gained}} = m_B\,c_B(T - T_B) = m_B c_B(\Delta T)_B$

According to the law of heat exchange; $\Delta Q_{\text{lost}} = \Delta Q_{\text{gained}}$

$$m_A c_A(\Delta T)_A = m_B\,c_B(\Delta T)_B$$



(a) (b)

Figure 1 (a) copper block in boiling water (b) copper block in calorimeter

Procedure

1. Measure the masses of calorimeter m_c, copper block m_m and water m_w (to fill the calorimeter) using the laboratory balance.
2. Fasten the copper block with a light string and hang it inside the beaker without touching the wall.
3. Heat the beaker until the water boils and measure the temperature T_i.
4. Fill the calorimeter with water at room temperature. A few minutes later record the temperature of calorimeter and water T_w.
5. Quickly transfer the copper block which is immersed in the boiling water into the calorimeter. Stir well and continuously for a little while (till the temperature becomes steady), then note down the temperature of the mixture T_f.
6. Calculate the specific heat capacity of the copper sample c_m.

Mass of calorimeter m_c ________ kg

Mass of copper block m_m ________ kg

Mass of water m_w ________ kg

Initial temperature of calorimeter and water T_w ________ °C

Initial temperature of copper block T_i ________ °C

Final temperature of mixture T_f ________ °C

Specific heat capacity of calorimeter (given value) c_c ________ J kg⁻¹K⁻¹

$$c_m = \frac{(m_c c_c + m_w c_w)(T_f - T_w)}{m_m (T_m - T_f)}$$

Result

- The specific heat capacity of copper is ________ $\text{J kg}^{-1}\text{K}^{-1}$

Precautions

- The temperature must be stable while recording.
- No spill of water.
- The thermometer bob is well dip in water but not touch the walls.
- Extreme care is necessary to prevent the heat burning of students.

Discussion

EXPERIMENT 4

VELOCITY OF SOUND IN AIR USING A RESONANCE TUBE

Aim of Experiment

- To determine the velocity of sound in air at room temperature using a resonance tube.

Apparatus

Resonance tube apparatus, tuning forks of known frequency (preferably of 480 Hz and 512 Hz), metre rule, rubber pad

Theory

When a vibrating tuning fork of known frequency f is held over the top of a resonance tube with adjustable air column, a standing wave pattern could be formed in the tube. At the proper length of the air column, a superposition between a forward moving and reflected wave occurs in the tube to cause resonance. This gives a very noticeable rise in the loudness of the sound. At resonance, a node must be formed at the closed end (water surface) and an antinode must be formed at the open end. Let the first loud sound be heard at length l_1 of the air column. That is, when the natural frequency of the air column of length l_1 becomes equal to the frequency of the tuning fork, the air column vibrates with the maximum amplitude. However, the antinode at the top does not coincide exactly with the top of the tube. It is therefore, necessary to include end correction c.

$$\frac{\lambda}{4} = l_1 + c \tag{1}$$

where c ($\approx 0.6\ r$, where r = radius of the glass tube) is the end correction for the resonance tube and λ is the wavelength of the sound produced by the tuning fork. Now on further lengthening of the air column, the second resonance can be heard at length l_2 of the air column in the tube. This length l_2 would approximately be equal to three quarters of the wavelength. That is

$$\frac{3\lambda}{4} = l_2 + c \tag{2}$$

Subtracting Eq. (1) from Eq. (2) gives $\frac{\lambda}{2} = l_2 - l_1$

Thus, the velocity of sound in air at room temperature ($v = f\lambda$) would be $v = 2f(l_2 - l_1)$.

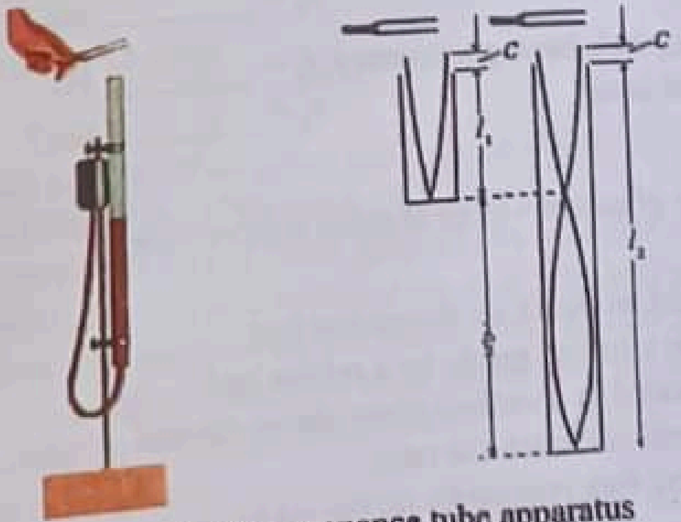


Figure 1 The resonance tube apparatus

Procedure

1. Set the resonance tube as vertically as possible.
2. Read the room temperature with a thermometer.
3. Note the frequency of given tuning fork.
4. Fill the water in the tube up to its open end.
5. Gently strike the given tuning fork on a rubber pad and place the vibrating tuning fork horizontally about 1 cm above the open end of the tube.
6. Slowly loosen the pinch cork to let the water level fall in the tube very slowly and notice the increasing loudness of the sound.
7. At a certain length of air column, a loud sound of resonance will be heard. Close the pinch cork and measure the length of air column l_1.
8. After getting the first resonance, continue the procedure steps 5, 6 and 7 to obtain the length l_2 of the second resonance.
9. Calculate the velocity of sound.
10. Repeat the above procedures by using another tuning fork of different frequency.

Observation

1. Room temperature, $T =$ ________ °C
2. Frequency of first tuning fork, $f_1 =$ ________ Hz
3. Frequency of second tuning fork, $f_2 =$ ________ Hz

Determination of length of the resonant air columns

frequency of tuning fork f(Hz)	Sr. No.	first resonance l_1 (cm)	second resonance l_2 (cm)	velocity of sound $v = 2f(l_2 - l_1)$ (ms^{-1})
	1			
	2			
	1			
	2			

(i) For first tuning fork having frequency, $f_1 =$ ________ Hz
Velocity of sound in air, $v_1 =$ ________ ms^{-1}

(ii) For second tuning fork having frequency, $f_2 =$ ________ Hz
Velocity of sound in air, $v_2 =$ ________ ms^{-1}

Result

- The average velocity of sound v in air at room temperature = ________ ms^{-1}.

Precautions

- Resonance tube should be struck on the rubber pad.
- Tuning fork should be vibrated gently by a rubber pad.
- Prongs should be vibrated in a vertical plane above the end of tube.
- Vibrating prongs should not touch the tube.
- Do not strike the tuning fork repeatedly on the rubber pad.

Discussion

EXPERIMENT 5

SNELL'S LAW AND REFRACTIVE INDEX

Aim of Experiment

- To verify Snell's law and determine the refractive index of glass.

Apparatus

Semi-circular glass slab, light source (laser pointer), protractor and ruler, sketch paper

Theory

When light passes from one medium into an optically different medium at an angle other than normal to the surface, it is "bent" or undergoes a change in direction, as illustrated in Figure.

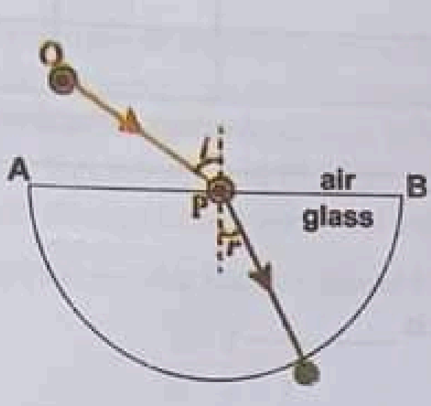


Figure 1 Refraction of light in semi-circular glass slab

This bending, or change in the direction of the ray occurs only at the interface between the two materials. Snell's Law states that the ratio of the sine of the angle of incidence to the sine of the angle of refraction is a constant.

That constant is the refractive index n of medium through which the refracted ray passes.

For refraction of light from air to glass, the refractive index of glass is $n_g = \frac{\sin i}{\sin r}$.

where i = angle of incidence

r = angle of refraction

n_g = refractive index of glass

Procedure

1. Place semi-circular glass slab on white paper and trace an outline around it. Draw a line normal at the centre of plane surface of the glass block.
2. Strike a ray of light from a light source (laser pointer) at a specified angle to the centre of plane surface of the slab. The incident ray and refracted ray should be easily seen.
3. Mark the points to indicate the incident ray, the refracted ray and the point of incidence.
4. Remove semi-circular glass slab and carefully trace the incident ray and refracted ray.
5. Measure the angle of incidence and angle of refraction.
6. Repeat for other angles of incidence.

Sr. No.	angle of incidence i (degree)	angle of refraction r (degree)	$\sin i$	$\sin r$	refractive index of glass $n_g = \frac{\sin i}{\sin r}$
1.					
2.					
3.					
4.					
5.					
			Average refractive index		

Result

- The refractive index of glass is ________.

Precautions

- Do not move the glass block once its outline has been drawn.
- Parallax error associated with measuring angles using the protractor.

Discussion

EXPERIMENT 6

FOCAL LENGTH OF A CONVEX LENS

Aim of Experiment

- To find the image distances formed in a convex lens for various object distances.
- To calculate the focal length of this convex lens.

Apparatus

Optical bench, a thin convex lens, a lens holder fitted in a stand, screen, light source (laser pointer), (or) object pin, image pin

Theory

The position, nature and size of the images of an object formed by a thin convex lens depends on the position of the object and can be studied using sign convention and ray diagrams. There are two types of images: (i) real images (they are formed by the light rays which after refraction actually intersect at a point and can be sharply formed on a screen) and (ii) virtual images (they are formed by the light rays which after refraction appear to diverge from a point and cannot be formed on a screen).

The lens formula relates the object distance (*u*), image distance (*v*) and focal length (*f*):

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

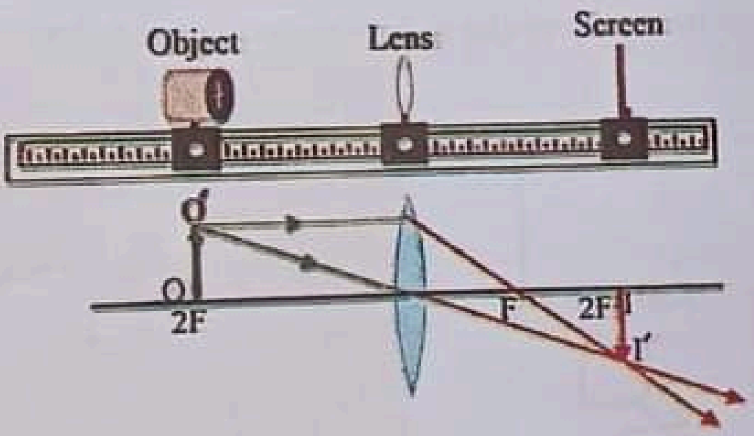


Figure 1 Formation of image by convex lens

Procedure

Light source and screen method

1. Find the approximate focal length by focusing the image of a distant object (building, trees) on the screen.
2. Assemble the equipment as shown in the diagram using the convex lens.
3. Place light source at a certain point (beyond 2F, at 2F, between 2F and F) from a convex lens and measure the object distance.
4. Adjust the position of the screen to receive a sharp image on it.
5. Measure the image distance and calculate the focal length of the lens.
6. Repeat the above procedure for other object distances.

Approximate focal length of convex lens = ________ cm

Sr. No.	object distance u (cm)	image distance v (cm)	focal length $f = \frac{uv}{u+v}$ (cm)
1.			
2.			
3.			
		Average focal length	

Result

- The focal length of convex lens is ________ cm.

Precautions

1. The lens must be upright position.
2. Measure the distances carefully.
3. The image formed on the screen must be as sharp as possible.

Discussion

EXPERIMENT 7

OHM'S LAW

Aim of Experiment

- To verify Ohm's law and determine the resistance of a metal wire.

Apparatus

Ammeter, voltmeter, rheostat (or) potentiometer, dry cell (or) battery (or) power supply, metre rule, nichrome wires of different lengths (heating wire for electric stove), connecting cables, plug key

Theory

One of the fundamental laws in electricity is Ohm's law. According to Ohm's law, there is a linear relationship between the voltage drop across a circuit element and the current flowing through it. Therefore the resistance R is viewed as a constant independent of the voltage and the current as long as the temperature is constant. In equation form, Ohm's law is $I = \frac{1}{R}V$.

where V = voltage applied across the circuit element and has SI unit of volt (V)
I = current flowing through the circuit element and has SI unit of ampere (A)
R = resistance of the circuit element and has SI unit of ohm (Ω)

Equation implies that, for a resistor with constant resistance, the current flowing through it is proportional to the voltage across it.

If the voltage is held constant, then the current is inversely proportional to the resistance of resistor.

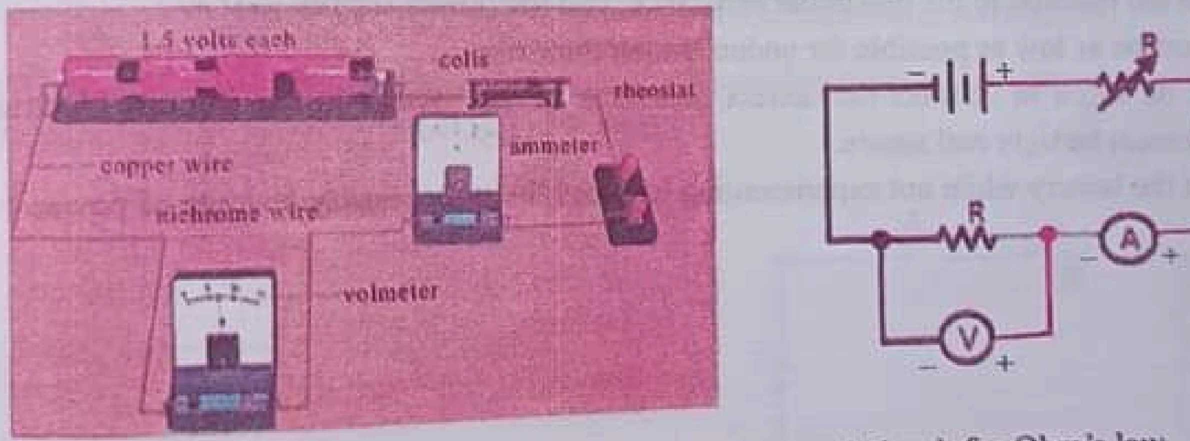


Figure 1 Experimental arrangement and circuit for Ohm's law

Procedure

1. Initially set the rheostat to the maximum resistance, and the power supply to 0 V. Using the connecting cables, ammeter and voltmeter (multimeters), power supply, rheostat and resistance wire, set up the circuit as shown in figure.
2. Turn on the power supply and adjust the rheostat until the voltmeter reads 1.0 V. Read the ammeter and record the corresponding current in the table.
3. Repeat step 2 for voltmeter reading of 2.0 V, 3.0 V, 4.0 V and 5.0 V.
4. Calculate the resistance of the wire and the average value of resistance.
5. Plot the voltage versus current data in your data table.
6. Find the slope, which give the reciprocal of resistance. Compare this value with the average value of resistance from the table.

Sr. No.	voltage V (V)	current I (mA)	resistance R (Ω)
1.	1		
2.	2		
3.	3		
4.	4		
5.	5		
		Average value of resistance	

Result

- Average resistance = ________ Ω
- From graph, reciprocal of slope = $R = \frac{\Delta V}{\Delta I}$ = ________ Ω

Precautions

- Initially set the rheostat to the maximum resistance, and the power supply to 0 V.
- Current must be as low as possible for undue temperature rise.
- Care must be taken to connect the correct polarities of the meters in the circuit. Electrical connection must be tight and secure.
- Disconnect the battery while not experimenting to avoid the unnecessary leakage of power.

Discussion

EXPERIMENT 8

LOGIC GATES

Aim of Experiment

- To construct and verify the truth table of three basic logic gates (NOT gate, AND gate and OR gate) using switches.

Apparatus

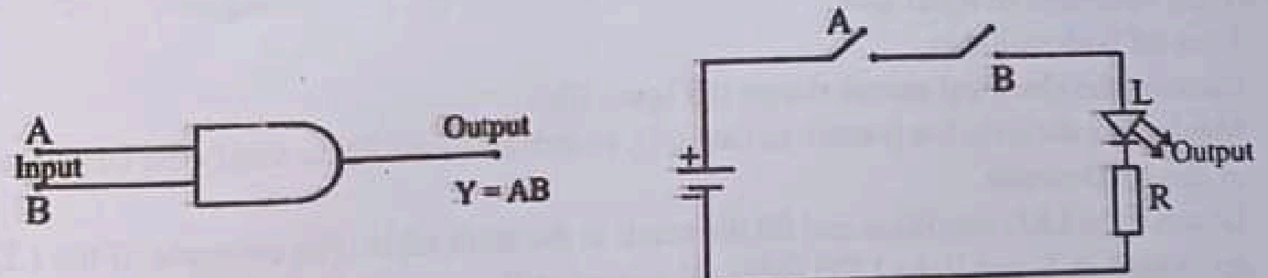
LEDs, 1.5 V battery, connecting wires, simple switches

Theory

Different types of logic gates can be built from different arrangements of electronic components. Logic gates can be built up using switches, resistors and transistors, but nowadays it is far more convenient to use small integrated circuits (ICs). Each circuit has all the necessary electronic components already connected together on a tiny piece of silicon. The five common logic gates are AND, OR, NAND, NOR and NOT (inverter) gates.

An AND gate can have two or more inputs and performs what is known as logical multiplication. But, an AND gate can have any number of inputs greater than one. An AND gate produces a HIGH output only when all of the inputs are HIGH. When any of the inputs is LOW, the output is LOW. Therefore, the basic purpose of an AND gate is to determine when certain conditions are simultaneously true, as indicated by HIGH levels on all of its inputs, and to produce a HIGH on its output to indicate that all these conditions are true. For a 2-input AND gate, output X is HIGH only when inputs A and B are HIGH; X is LOW when either A or B is LOW, or when both A and B are LOW.

The AND gate is implemented by connecting two switches together in series shown in Figure 1. Both switches must be closed for the lamp to light up.



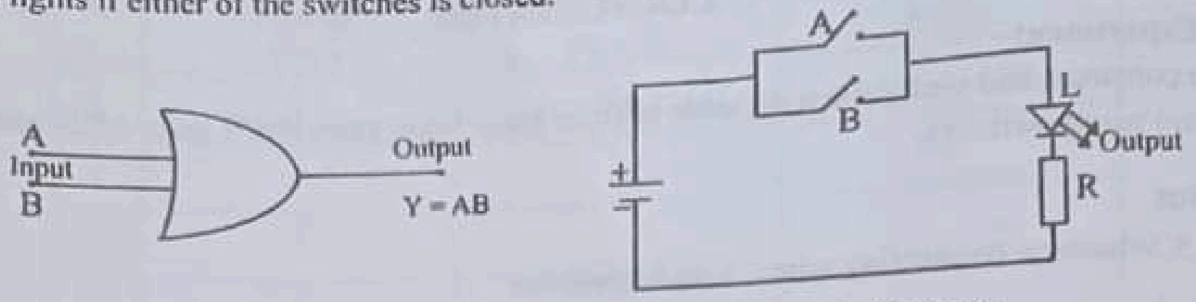
(a) Logic symbol

(b) Electrical Circuit

Figure 1 Logic symbol and electrical circuit for AND gate

An OR gate can have two or more inputs and performs what is known as logical addition. But, an OR gate can have any number of inputs greater than one. An OR gate produces a HIGH on the output when any of the inputs is HIGH. The output is LOW only when all of the inputs are LOW. Therefore, an OR gate determines when one or more of its inputs are HIGH and produces a HIGH on its output to indicate this condition. For a 2-input OR gate, output X is HIGH when either input A or input B is HIGH, or when both A and B are HIGH; X is LOW only when both A and B are LOW.

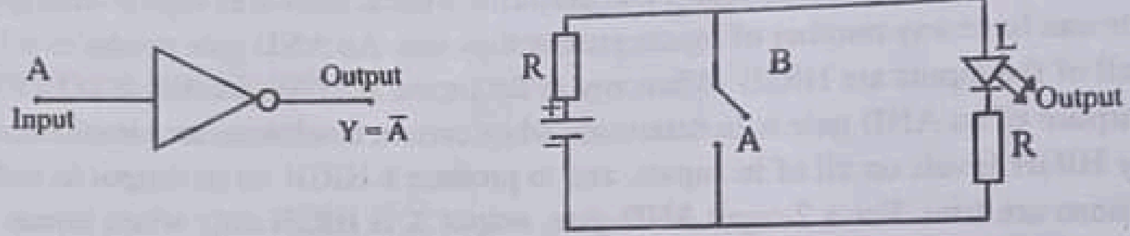
The OR gate is implemented by connecting two switches together in parallel shown in Figure 2. Then, the lamp lights if either of the switches is closed.



(a) Logic symbol (b) Electrical Circuit

Figure 2 Logic symbol and electrical circuit for OR gate

The inverter (NOT gate) performs the operation called inversion or complementation. The inverter changes one logic level to the opposite level. In terms of bits, it changes 1 to 0 and 0 to 1. When a HIGH level is applied to an inverter input, a LOW level will appear on its output. When a LOW level is applied to its input, a HIGH will appear on its output.



(a) Logic symbol (b) Electrical Circuit

Figure 3 Logic symbol and electrical circuit for NOT gate

Procedure

To verify the operation of AND gate.

1. Turn off both switches.
2. Connect the electrical circuit shown in Figure 1(b).
3. Manipulate the switches [switch on (logic 1), switch off (logic 0)] to verify the correct operation of the AND circuit.
4. Observe the LED condition and fill the result in the truth table. For example, if the LED lights up, regard as 1, and if the LED lights off, regard as 0.

To verify the operation of the OR gate.

1. Turn off both switches.
2. Connect the electrical circuit shown in Figure 2(b).
3. Manipulate the switches [switch on (logic 1), switch off (logic 0)] to verify the correct operation of the OR circuit.
4. Observe the LED condition and fill the result in the truth table. For example, if the LED lights up, regard as 1, and if the LED lights off, regard as 0.

For verifying the operation of the NOT gate.

5. Turn off switch .
6. Connect the electrical circuit shown in Figure 3(b).

7. Manipulate the switch [switch on (logic 1), switch off (logic 0)] to verify the correct operation of the NOT circuit.
8. Observe the LED condition and fill the result in the truth table. For example, if the LED lights up, regard as 1, and if the LED lights off, regard as 0.

Result

AND gate

A	B	X
0	0	
0	1	
1	0	
1	1	

OR gate

A	B	X
0	0	
0	1	
1	0	
1	1	

NOT gate

A	X
0	
1	

Precautions

- Connect carefully the correct polarities of LEDs.
- Connections should be correctly.
- Connections must be tight.

Discussion

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