

## SECOND SEMESTER

### PRACTICAL -II

#### REFRACTIVE INDEX

**Experiment No.:**

**Date:**

**Aim:**

To determine the refractive index of a transparent liquid (water) using travelling microscope.

**Apparatus required:**

Given liquid, glass beaker, travelling microscope, lycopodium powder, pin, etc.

**Formula:**

The refractive index of liquid (water)

$$\begin{aligned}\mu &= \frac{\text{Real depth of the liquid}}{\text{Apparent depth of the liquid}} \\ &= \frac{\text{Reading 3} - \text{Reading 1}}{\text{Reading 3} - \text{Reading 2}}\end{aligned}$$

**Description:**

A travelling microscope is an ordinary microscope fixed on a stand in such a way that it may be made to travel in vertical as well as horizontal direction without disturbing its adjusted focus. The readings are recorded by means of main scale and vernier scale of high accuracy (0.001 cm) attached to the instrument.

**Procedure:**

The least count of the microscope is determined as in the case of vernier calipers.

A small pin is fixed horizontally with wax or cello tape at the bottom of the empty beaker. The tip of pin is focussed clearly on the microscope and the corresponding main scale reading (MSR) and vernier scale coincidence (VSC) in the vertical scale are noted in the tabular column. (Reading 1)

The given liquid is taken in the beaker. Now the pin is apparently raised through a height. Therefore, it will be no longer in focus. The microscope is moved up without changing the adjusted focus, so that the image of the pin is clearly seen through the microscope. The corresponding main scale reading (MSR) and vernier scale coincidence (VSC) in the vertical scale are noted in the tabular column. (Reading 2)

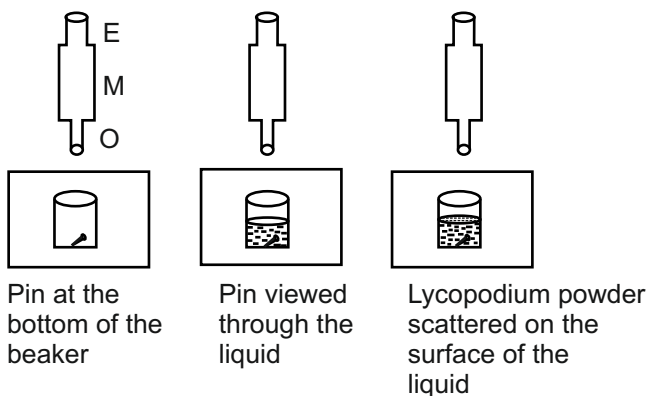
Finally, a little lycopodium powder or saw dust which can float on liquid is scattered on the surface of the liquid. The microscope is further moved up without changing the adjusted focus, so that the clear image of lycopodium powder is seen through the microscope. The corresponding main scale reading (MSR) and vernier scale coincidence (VSC) in the vertical scale are noted in the tabular column. (Reading 3)

The difference between this Reading 3 and Reading 1 gives the real depth of the liquid, whereas the difference between Reading 3 and Reading 2 gives the apparent depth of the liquid.

By substituting the readings in the formula, the refractive index of the liquid (water) is determined.

### Result:

The refractive index of the liquid (water) =



**To find Least count of microscope:**

Least count: Value of 20 MSD = cm

Value of 1 MSD = cm

No. of divisions on the vernier scale(n) =

=

$$\text{Least Count (LC)} = \frac{1}{n} \times \text{value of 1 MSD}$$

= cm

**Tabular column:**

Least count = cm

Position	Microscope Readings			
	MSR	VSC	VSR = VSC x LC	OR = MSR + VSR
Unit	cm	div	cm	cm
Clear image of tip of the pin fixed at the bottom of the beaker.				(Reading 1)
Clear image of tip of the pin, after the liquid is taken in the beaker.				(Reading 2)
Clear image of lycopodium powder scattered on the surface of liquid.				(Reading 3)

**Calculation:**

The refractive index of liquid (water)

$$\mu = \frac{\text{Real depth of the liquid}}{\text{Apparent depth of the liquid}}$$

Real depth of the Liquid = Reading 3 – Reading 1  
 = cm - cm  
 = cm  
 Apparent depth of the liquid = Reading 3 – Reading 2  
 = cm - cm  
 = cm  
 Refractive index of the liquid  $\mu =$

## SOLAR CELL

**Experiment No.:**

**Date:**

**Aim:**

To draw the V-I characteristics curve for the given solar cell.

**Apparatus required:**

Solar cell, milliammeter (0 – 100 mA), voltmeter (0 – 2 V), variable resistor (0 – 1 k $\Omega$ ), 60 W bulb, connecting wires, plug key.

**Theory:**

The solar cell is a semiconductor device that converts solar energy (electromagnetic radiation) into electrical energy by photovoltaic effect. Solar cells are widely used to produce electrical energy from sun's radiation.

A solar cell consists of a p-n junction diode, in which electrons and holes are generated by the incident photons (i.e. electromagnetic radiation). When an external circuit is connected through the p-n junction device, a current passes through the circuit. Therefore, the device generates power when the electromagnetic radiation is incident on it.

**Procedure:**

A voltmeter, milliammeter and a variable resistor of 0 to 1000 ohm and a plug key are connected as shown in the circuit diagram.

The solar cell is illuminated by a filament bulb of 60 W. Now the two pins of the solar cell are plugged in to the two terminals (A and A) of the

milliammeter and the short circuit current  $I_{sc}$  is noted, keeping the plug key in open condition.

Then the two pins of the solar cell are plugged into the two terminals (V and V) of the voltmeter and the open circuit voltage  $V_{oc}$  is noted, keeping the plug key in open condition.

Now the plug key is closed to include the variable resistor in the circuit. By slowly changing the value of resistance included in the circuit, the milliammeter readings are noted for various values of voltmeter readings in steps of 0.1 V or 0.2 V.

The readings of both the milliammeter and voltmeter are entered in the tabular column. With these readings, the  $V - I$  characteristics graph of the solar cell is drawn.

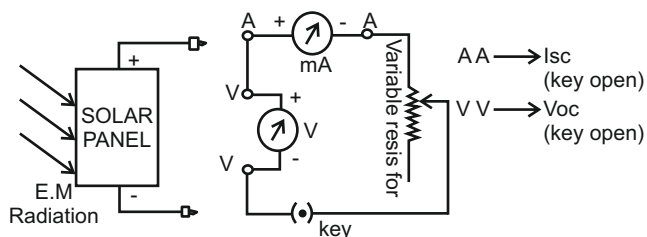
### Result:

Thus the  $V-I$  characteristics of the solar cell is drawn.

### Note:

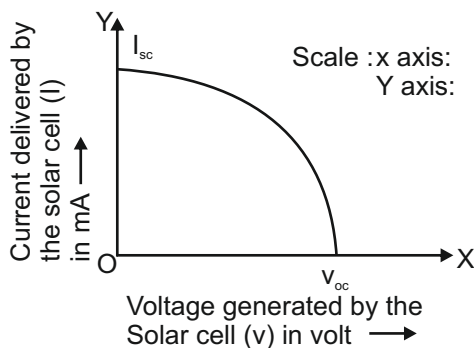
- i) The  $V_{oc}$  and  $I_{sc}$  values depend on the type of solar cell and number of solar cells used in the solar panel.
- ii) These values also depend on the source of electromagnetic radiation, which we use to irradiate the solar cell.
- iii) Care should be taken so that the bulb and solar cell do not come into direct contact. (I.e. touch each other). In such case the readings of the meters may go beyond the range and the solar cell may get damaged.

### Circuit Diagram



**Tabular Column:**Short circuit current  $I_{sc}$  =      mAOpen circuit voltage  $V_{oc}$  =      volt

S.No	Voltage generated by the solar cell (V)	Current delivered by the solar cell (I)
Unit	volt	milliampere

**Model Graph:****SPECTROMETER****Experiment No.:****Date :****Aim:**

To determine the angle of the prism and the angle of minimum deviation using spectrometer and to calculate the refractive index of glass.

**Apparatus required:**

Spectrometer, given glass prism, Sodium vapour lamp, Reading lens, black cloth, etc.

**Formula:**

The refractive index of the material of the glass prism

Where  $A$  = angle of the prism

$D$  = angle of minimum deviation

**Description :**

$$\mu = \frac{\sin\left[\frac{A+D}{2}\right]}{\sin\left[\frac{A}{2}\right]}$$

Spectrometer is an optical instrument having three parts

(i) Collimator (ii) Telescope and (iii) Prism table. The following initial adjustments should be carried out before starting any experiment with a spectrometer.

- The telescope is turned towards a white wall of background and the eyepiece is gently pushed in or pulled out so that a clear image of the cross wires is seen without parallax.
- To adjust the telescope for parallel rays, the telescope is directed towards a distant object like distant tree or building and the distance between the objective lens and the eyepiece is altered till the clear image of the distant object is seen in the field of view of telescope.
- To adjust the collimator for parallel rays, the slit of the collimator is illuminated with a monochromatic source of light (sodium vapour lamp). The telescope is brought in line with the collimator in order to catch the image of the slit in the telescope. The distance between the convex lens in the collimator and the slit is altered to get the clear image of the slit through the telescope, so that the width of the slit is minimized.
- The prism table is made perfectly horizontal by adjusting the screws provided with the help of the spirit level.

**Procedure:****Angle of the prism A:**

After making initial adjustments, the least count of the spectrometer is determined (as in Vernier Calipers).

Having a very fine slit, the telescope is adjusted for direct ray. A prism is placed on the prism table as shown in the figure. The telescope is turned to catch the reflected image from one polished face AB of the prism. Fixing in that position, the tangential screw is adjusted till the vertical cross wire is made to coincide with the fixed edge of the image of the slit. The readings in the scales I and II are noted.

The telescope is then turned to the other polished face AC of the prism. The readings in the scales I and II are noted when the vertical cross wire coincides with the fixed edge of the image of the slit. The difference between both the scale I readings is  $2A$ . Similarly the difference between both the scale II readings is  $2A$ . Then the average of the angle of the prism  $A$  is calculated.

**Angle of minimum deviation D:**

The prism is placed on the prism table as shown in the figure. The ray of light from the collimator incident on one polished face of the prism gets refracted and emerges out of the other polished face. Viewing the image of the slit through the telescope, the prism table and telescope are rotated simultaneously through small angle such that the image of the slit moves towards the direct ray. At one stage, it is found that the image of the slit is stationary for a moment and on rotating the prism table further in the same direction the image begins to retrace its path. The telescope is fixed at that position, the cross wire is made to coincide with the fixed edge of the image of the slit. At this minimum deviation position, the readings of scales I and II are noted.

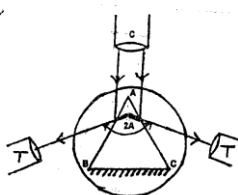
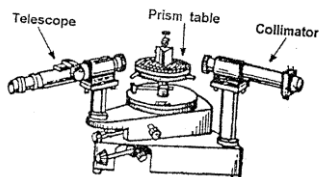
The prism is removed from the prism table. The telescope is brought in line with the collimator and the image of the slit is seen through the telescope. The vertical cross wire is made to coincide with the fixed edge of the image of the slit. The readings in the scales I and II are noted.

The difference between the two readings of scale I or scale II gives the angle of minimum deviation  $D$ . Hence the refractive index of the material of the prism is calculated using the formula.



## Result:

The refractive index of the material of the prism  $\mu =$



## Observations:

Least count of Spectrometer:

Value Of 20 MSD

=

Value of 1 MSD

=

No. divisions on the Vernier scale (n)

=

=

Least Count (LC)

$$= \frac{1}{n} \times \text{value of 1MSD}$$

=

## Tabular column I:

To determine the angle of the prism A

LC =

Ray	Spectrometer readings in degree							
	Scale I				Scale II			
	MSR	VSC	VSR = VSC $\times$ LC	OR = MSR + VSR	MSR	VSC	VSR = VSC $\times$ LC	OR = MSR + VSR
Reading of the reflected ray (left)				$x_1 =$				$x_3 =$
Reading of the reflected ray(right)				$x_2 =$				$x_4 =$

$$2A = (x_1 \sim x_2) =$$

$$A = \frac{\quad}{2} =$$

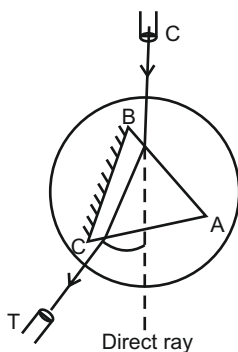
The average angle of the prism A

$$2A = (x_3 \sim x_4) =$$

$$A = \frac{\quad}{2} =$$

$$= \frac{\quad + \quad}{2}$$

=



### Tabular column II:

To determine the angle of the minimum deviation D

LC =

Ray	Spectrometer readings in degree							
	Scale I				Scale II			
	MSR	VSC	VSR = VSC $\times$ LC	OR = MSR + VSR	MSR	VSC	VSR = VSC $\times$ LC	OR = MSR + VSR
Reading of minimum deviated ray				$d_1 =$				$d_3 =$
Reading of Direct ray				$d_2 =$				$d_4 =$

The angle of the minimum deviation of the prism  $D = \frac{D_1 + D_2}{2}$

$$D_1 = (d_1 \sim d_2) =$$

$$D_2 = (d_3 \sim d_4) =$$

=

**Calculation:**

$$\mu = \frac{\sin\left[\frac{A + D}{2}\right]}{\sin\left[\frac{A}{2}\right]} = \quad =$$

The refractive index of the material of the glass prism

## OHM'S LAW

### Verification of Laws of Resistances

**Experiment No.:**

**Date:**

**Aim:**

To verify the laws of resistances when the two given standard resistances are connected i) in series and ii) in parallel, using Ohm's law.

**Apparatus required:**

Two known standard resistances, battery, key, rheostat, ammeter, voltmeter, connecting wires, etc.

**Formulae:**

i) When two resistances  $R_1$  &  $R_2$  are connected in series, their effective resistance is given by the formula  $R_s = R_1 + R_2$

$$R_s = \frac{E}{I}$$

The formula for determining the effective resistance by experiment is

ii) When two resistances  $R_1$  &  $R_2$  are connected in parallel, their

$$R_p = \frac{R_1 \times R_2}{R_1 + R_2}$$

effective resistance is given by the formula

$$R_p = \frac{E}{I}$$

The formula for determining the effective resistance by experiment is where

$R_1$  = the value of the one standard resistance

$R_2$  = the value of the other standard resistance

$E$  = Potential difference between the ends of the resistances  
(Voltmeter reading)

$I$  = Current flowing through the resistances (Ammeter reading)

### **Procedure:**

#### **Resistances in series:**

The given two resistances  $R_1$  and  $R_2$  are connected in series. This combination is again connected in series with a battery eliminator, key, rheostat and an ammeter. The voltmeter is connected in parallel to the combination of resistances to measure the potential difference across the resistances.

Now the circuit is closed. By adjusting the rheostat for different values of current, the corresponding values of potential difference are noted in tabular column I. The effective resistance  $R_s$  is calculated in each case using the formula. Then the average value of effective resistance  $R_s$  is calculated.

#### **Resistances in parallel:**

The given two resistances  $R_1$  and  $R_2$  are connected in parallel. This combination is again connected in series with a battery eliminator, key, rheostat and an ammeter. The voltmeter is connected in parallel to the combination of resistances, to measure the potential difference across

the resistances.

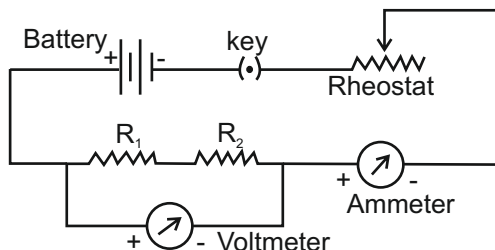
Now the circuit is closed. By adjusting the rheostat for different values of current, the corresponding values of potential difference are noted in tabular column II. The equivalent resistance  $R_p$  is calculated in each case using the formula. Then the average value of effective resistance  $R_p$  is calculated.

### Result:

- 1) When the resistances are connected in series:
  - i. The effective resistance by calculation  $R_s =$  ohm
  - ii. The effective resistance by experiment  $R_s =$  ohm
- 2) When the resistances are connected in parallel:
  - i. The effective resistance by calculation  $R_p =$  ohm
  - ii. The effective resistance by experiment  $R_p =$  ohm

The laws of resistances are verified, using Ohm's law.

### Circuit diagram for series connection



Resistance  $R_1 =$  ohm; Resistance  $R_2 =$  ohm

Effective resistance  $R_s = R_1 + R_2$   
 $=$  ohm  $=$  ohm

# **Tabular column I:**

Sl. No	Current flowing through the resistances (Ammeter reading) $I$		Potential difference between the ends of resistances (Voltmeter reading) $E$		$R_s = \frac{E}{I}$
Unit	div	ampere	div	volt	ohm
1.					
2.					
3.					
4.					
5.					

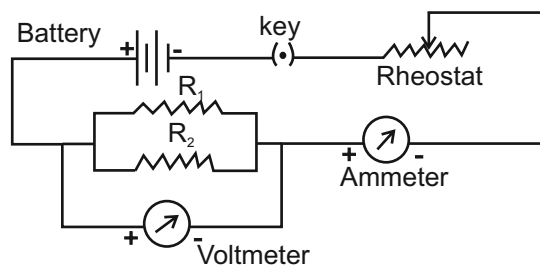
To find the value of effective resistance when  $R_1$  and  $R_2$  are in series

Average value of effective resistance when  $R_1$  and  $R_2$  are connected in series  $R_s =$  ohm

1)  $E =$  volt ;  $I =$  ampere;  $R_s = \frac{E}{I} =$

## **Calculation:**

2)



## **Circuit diagram for parallel connection**

Resistance  $R_1 =$  ohm; Resistance  $R_2 =$  ohm  
 $R_p = \frac{R_1 \times R_2}{R_1 + R_2} =$

Effective resistance

= ohm

**Tabular column II:**

Sl. No	Current flowing through the resistances (Ammeter reading) I		Potential difference between the ends of resistances (Voltmeter reading) E		$R_s = \frac{E}{I}$
Unit	div	ampere	div	volt	ohm
1.					
2.					
3.					
4.					
5.					

To find the value of effective resistance when  $R_1$  and  $R_2$  are in parallel

Average value of effective resistance when

$R_1$  and  $R_2$

are connected in parallel  $R_p =$  ohm

1)  $E =$  volt ;  $I =$  ampere;  $R_p = \frac{E}{I} =$  ohm

**Calculation:**

2)

## METRE BRIDGE

**Experiment No.:**

**Date:**

**Aim:**

To determine the unknown resistance of the given wire.

**Apparatus required:**

Metre bridge, given wire, variable resistance box, Leclanche cell,

plug key, galvanometer, high resistance, jockey, connecting wires, etc.

$$X = \frac{X_1 + X_2}{2}$$

### Formulae:

$$X_1 = R \frac{l_1}{l_2} \text{ when the resistance box } R \text{ is in the right gap } (G_2)$$

$$X_1 = R \frac{l_4}{l_3} \text{ when the resistance box } R \text{ is in the left gap } (G_1)$$

The resistance of the given wire is

where

$R$  = value of resistance introduced in the resistance box

$l_1, l_2, l_3$  and  $l_4$  are balancing lengths.

### Description:

A metre bridge consists of a uniform wire AC of length one metre. It is stretched on a wooden board. The ends of the wire are fixed to two thick L shaped copper strips at A and C. Binding screws are provided at the ends of the strips. A third copper strip is fixed on the wooden board between the first two strips so as to form two gaps  $G_1$  and  $G_2$ . This strip is provided with three binding screws. A metre scale is fixed on the wooden board parallel to the length of the wire to measure the balancing lengths. A jockey J is provided by means of which contact can be made at any point on the wire.

### Procedure:

The unknown resistance  $X$  (given wire) which is to be determined is connected in the gap  $G_1$  and a resistance box  $R$  is connected in the gap  $G_2$ .

A Leclanche cell and a key  $K$  are connected between the points A and C. A galvanometer, high resistance and the jockey are connected as shown in figure.

A suitable resistance (say  $2.0\Omega$ ) is introduced in the resistance box  $R$ . Now the key is closed and the jockey is pressed at a point near the end A of metre bridge wire and then at a point near the end C. If the deflections in the galvanometer are in opposite directions, then the connections are correct.



The jockey is gently slid from A end on the bridge wire AC till the galvanometer shows null deflection and the balancing point J is found. The balancing length AJ is measured as  $l_1$  and the remaining length JC is noted as  $l_2$  i.e.  $l_2 = (100 - l_1)$ . The experiment is repeated by increasing the values introduced in the resistance box in steps of  $0.2 \Omega$ . The readings are tabulated. The resistance of given coil of the wire is calculated using the given formula. The average value of the  $X_1$  is found.

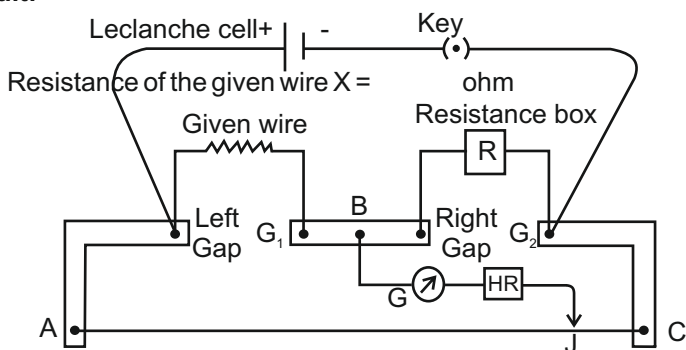
The given wire X and resistance box R are interchanged i.e. the unknown resistance X (given wire) is connected in the gap  $G_2$  and the resistance box R is connected in the gap  $G_1$ .

A suitable value of resistance (say  $2\Omega$ ) is introduced in the resistance box R. Now the key is closed and the jockey is pressed at a point near the end A of metre bridge wire and then at a point near the end C. If the deflections in the galvanometer are in opposite directions, the connections are correct.

The jockey is gently slid from A end on the bridge wire AC till the galvanometer shows null deflection and the balancing point J is found. The balancing length AJ is measured as  $l_3$  and the remaining length JC is noted as  $l_4$  i.e.  $l_4 = (100 - l_3)$ . The experiment is repeated by increasing the values introduced in the resistance box in steps of  $0.2\Omega$ . The readings are tabulated. The resistance of given the wire is calculated using the given formula. The average value of  $X_2$  is found.

Using the values of  $X_1$  and  $X_2$ , the average value of unknown resistance is determined.

### Result:



**Tabular column I:**

Sl. No.	Known Resistance R	Balancing lengths				$x_1 = R \frac{l_1}{l_2}$
		$l_1$		$l_2 = 100 - l_1$	$l_2 = 1.0 - l_1$	
Unit	ohm	cm	m	cm	m	ohm
1.						
2.						
3.						
4.						
5.						

To find the unknown value of resistance  $X_1$  when R is in the gap  $G_2$

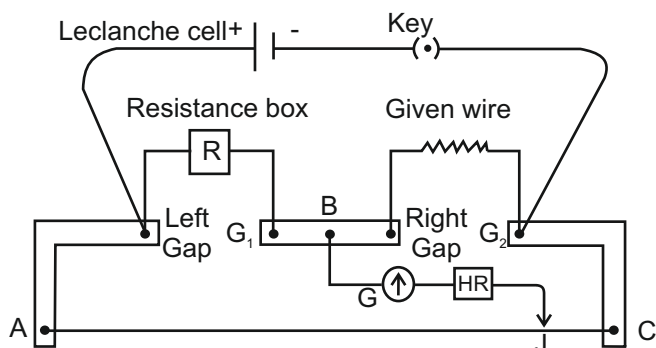
The average value of  $X_1 =$       ohm

**Calculation:**

$$x_1 = R \frac{l_1}{l_2} =$$

1) R =      ohm;  $l_1 =$       m;  $l_2 =$       m

$$x_1 = R \frac{l_1}{l_2} =$$



2)  $R =$  ohm;  $l_1 =$  m;  $l_2 =$  m

**Tabular column I:**

Sl. No.	Known Resistance R	Balancing lengths				$x_2 = R \frac{l_4}{l_3}$
		$l_3$		$l_4 = 100 - l_3$	$l_4 = 1.0 - l_3$	
Unit	ohm	cm	m	cm	m	ohm
1.						
2.						
3.						
4.						
5.						

To find the unknown value of resistance  $X_1$  when R is in the gap  $G_2$

The average value of  $X_2 =$  ohm

**Calculation:**

$$x_2 = R \frac{l_4}{l_3} =$$

1)  $R =$  ohm;  $l_3 =$  m;  $l_4 =$  m

$$x_2 = R \frac{l_4}{l_3} =$$

$$\text{Average resistance of the wire } x = \frac{x_1 + x_2}{2}$$

2)  $R =$  ohm;  $l_3 =$  m;  $l_4 =$  m  
 $=$  ohm

## POTENTIOMETER

**Experiment No.:**

**Date:**

**Aim:**

To compare the electromotive forces (e.m.fs) of the given two cells, using a potentiometer.

**Apparatus required:**

Potentiometer, given two cells (Leclanche cell and Daniel cell), battery eliminator, rheostat, plug key, two way key, galvanometer, high resistance, jockey, connecting wires, etc.

**Formula:**

$$\frac{E_1}{E_2} = \frac{l_1}{l_2}$$

The ratio of e.m.fs of two cells

where

$E_1$  = e.m.f of first cell (Leclanche cell)

$E_2$  = e.m.f of second cell (Daniel cell)

$l_1$  = balancing length when e.m.f of Leclanche cell is projected in the primary circuit

$l_2$  = balancing length when e.m.f of Daniel cell is projected in the primary circuit

**Description:**

The potentiometer consists of 4 m, 6 m or 10 m long wire of uniform resistance kept stretched on a wooden board between two terminals. To make the apparatus compact the wire is arranged on the board in zigzag manner in segments, each of one metre in length. A jockey is also provided to make contact at any point on the wire. A metre scale is fixed parallel to the length of the wire using which readings can be taken directly.

The battery  $B_a$ , key  $K$ , rheostat  $R_h$  and the potentiometer wire  $AB$

are connected in series. This is called primary circuit.

$E_1$  and  $E_2$  are the e.m.fs of the Leclanche cell and Daniel cell respectively which are to be compared. The positive terminals of Leclanche cell and Daniel cell are connected to the terminal A of potentiometer wire. The negative terminals are connected to the two outer terminals of two way key. Then the middle terminal of two way key is connected with jockey through galvanometer and high resistance. This is called secondary circuit.

### **Procedure:**

The primary circuit is closed and the rheostat in the primary circuit is adjusted to send a suitable current. The top gap of the two way key is closed to have Leclanche cell of e.m.f.  $E_1$  included in the circuit. Then the jockey is pressed at the ends A and B of the potentiometer wire. If the deflections in the galvanometer are in opposite directions, then the connections are correct. Similarly the Daniel cell of e.m.f.  $E_2$  is included in the circuit and the circuit connections are checked.

The rheostat's movable slide is kept at one end. Now, the top gap of the two way key is closed to have Leclanche cell of e.m.f  $E_1$  included in the circuit. The jockey is gently slid from A on the wire and the balancing point  $J_1$ , at which there is no deflection in the galvanometer, is obtained accurately. The balancing length  $AJ_1$  is measured as  $l_1$ .

Again, the bottom gap of the two way key is closed to have Daniel cell of e.m.f  $E_2$  included in the circuit. The jockey is gently slid from A end of the wire and the balancing point  $J_2$  is obtained accurately. The balancing length  $AJ_2$  is measured as  $l_2$ .

The experiment is repeated by adjusting movable slide of the rheostat for varying current in the primary circuit. In each case the balancing lengths  $l_1$  and  $l_2$  are measured and readings are tabulated in the tabular column. Then, the ratio of e.m.fs of two cells is calculated using the formula.

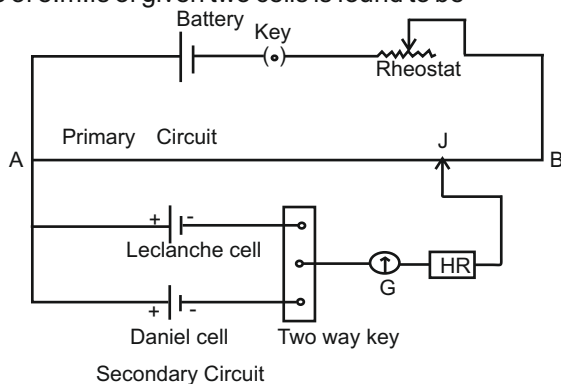
### **Note:**

If value of e.m.f of one of the two cells is known, the e.m.f of the other cell can be calculated using the formula  $(E_1/E_2) = (l_1/l_2)$ . If  $E_1$  is known, the

e.m.f of  $E_2$  can be calculated using  $E_2 = (E_1 \times I_2) / I_1$

**Result:**

- i) The e.m.fs of given two cells are compared.
- ii) The ratio of e.m.fs of given two cells is found to be =



**Tabular column :** To find  $\frac{E_1}{E_2} =$

Sl. No.	Balancing lengths				$\frac{E_1}{E_2} = \frac{l_1}{l_2}$
	For Leclanche cell (of emf $E_1$ ) $l_1$		For Daniel cell (of emf $E_2$ ) $l_2$		
Unit	cm	m	cm	m	
1					
2					
3					
4					
5					
6					
7					

The average of  $\frac{E_1}{E_2} =$

**Calculation:**

$$1. I_1 = \quad \text{m}; \quad I_2 = \quad \text{m}.$$

$$\frac{E_1}{E_2} = \frac{I_1}{I_2} =$$

$$2. I_1 = \quad \text{m}; \quad I_2 = \quad \text{m}.$$

$$\frac{E_1}{E_2} = \frac{I_1}{I_2} =$$

**JOULE'S CALORIMETER****Experiment No.:****Date:****Aim:**

To determine the specific heat capacity of water (liquid), using Joule's calorimeter.

**Apparatus required:**

Joule's calorimeter, battery eliminator, ammeter, voltmeter, rheostat, plug key, stop watch, thermometer, digital balance, liquid (water), connecting wires, etc.

**Formula:**

$$S = \frac{E I t}{(m_2 - m_1) (T_2 - T_1)} - \frac{m_1 S_c}{(m_2 - m_1)}$$

The specific heat capacity of the liquid

where

$E$  = potential difference across the heating coil (Voltmeter reading)

$I$  = current flowing through the heating coil (Ammeter reading)

$t$  = time for which the current flows to increase the temperature of water

$m_1$  = mass of empty and dry calorimeter with stirrer

$m_2$  = mass of calorimeter with stirrer and water

$S_c$  = specific heat capacity of the material of the calorimeter

$T_1$  = initial temperature of the liquid

and  $T_2$  = final temperature of the liquid

### **Description:**

The Joule's calorimeter consists of a brightly polished copper or aluminium vessel closed by an ebonite lid with two holes. A heating coil, connected to two binding screws provided on the ebonite lid is kept within the calorimeter. Through holes in the lid a sensitive thermometer and a stirrer can be inserted. The calorimeter is placed inside a wooden box stuffed with cotton or wool.

### **Procedure:**

The mass of the clean, dry calorimeter with stirrer ( $m_1$ ) is determined using a digital balance. The calorimeter is filled to two- third of its volume with the given liquid (water) and the mass ( $m_2$ ) is once again determined.

The calorimeter is kept in the wooden box and the heating coil is completely immersed in the liquid. Connections are given as shown in the circuit diagram.

The circuit is closed for a moment and the rheostat is adjusted for a suitable current of 0.8 A or 1.0 A. The ammeter and voltmeter readings are noted as  $I$  and  $E$  respectively. The circuit is kept open. Now, the liquid is stirred well and the initial temperature ( $T_1$ ) of the liquid is determined using a sensitive thermometer.

The circuit is again closed and simultaneously a stopwatch is started. The liquid is stirred slowly and uniformly. The temperature of the liquid is noted for every minute in the tabular column. When the temperature of the liquid is increased by  $5^\circ\text{C}$ , the key is removed and the stopwatch is stopped simultaneously.

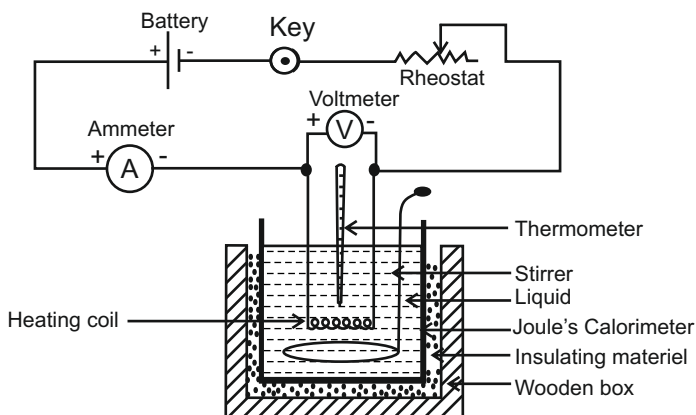
The time ( $t$  second) for which the current was flowing through the circuit is noted from the stopwatch. The specific heat capacity of the material of the calorimeter ( $S_c$ ) is taken from tables.

Then, the specific heat capacity of the water ( $S$ ) is calculated using the given formula.



**Result:**

The specific heat capacity of water is found to be  $S =$   $\text{J kg}^{-1} \text{K}^{-1}$

**Observation:**

Mass of the empty calorimeter with stirrer ( $m_1$ )	=	g
	=	kg
Mass of calorimeter with stirrer + water ( $m_2$ )	=	g
	=	kg
Current flowing through the heating coil (Ammeter reading)	$\left. \begin{array}{l} \} (I) \end{array} \right\} =$	A
Potential difference across the coil (Voltmeter reading)	$\left. \begin{array}{l} \} (E) \end{array} \right\} =$	V
Initial temperature of water	( $T_1$ ) =	$^{\circ}\text{C}$
Final temperature of water	( $T_2$ ) =	$^{\circ}\text{C}$
Time for which current is passed to increase the temperature of water	(t) =	minutes
	=	second
Specific heat capacity of the material of the calorimeter (copper)	$\left. \begin{array}{l} \} (S_c) \end{array} \right\} =$	$\text{J kg}^{-1} \text{K}^{-1}$

**Tabular column:**

To record the time taken for 5°C raise in temperature of water

Time in minutes	Temp. of water in °C

Time taken for 5°C raise in temp. of water (t) =        s

**Calculation:**

The specific heat capacity of water

$$S = \frac{EIt}{(m_2 - m_1)(T_2 - T_1)} - \frac{m_1 S_c}{(m_2 - m_1)}$$

$$= \quad \quad \text{J kg}^{-1} \text{K}^{-1}$$

**COPPER VOLTAMETER****Experiment No.:****Date:****Aim:**

To determine the electro chemical equivalent (e.c.e) of copper, using copper voltameter.

**Apparatus required:**

Copper voltameter, battery eliminator, plug key, rheostat, ammeter, stop watch, digital balance, connecting wires, emery sheet, etc.

**Formula:**

The electro chemical equivalent of copper

$$Z = \frac{m}{It} = \frac{m_2 - m_1}{It}$$

where

$m$  = mass of copper deposited on the cathode

$m_1$  = mass of the cathode before passing current

$m_2$  = mass of the cathode after passing current

$I$  = current flowing through the electrolyte (Ammeter reading)

$t$  = time of passage of current

### **Description:**

The copper voltameter consists of a glass vessel, containing a strong solution of copper sulphate. Three plates of copper are dipped in the solution. The two outer plates are connected together and they form the anode. The middle plate serves as the cathode.

### **Procedure:**

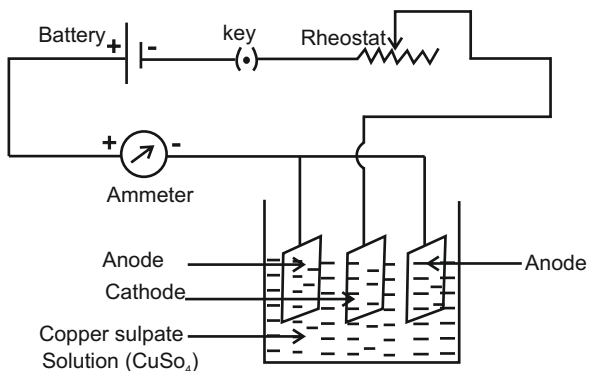
The copper voltameter is connected in series with the battery, plug key, rheostat and ammeter. It should be noted that the negative of the battery is connected to the central cathode plate. After making all the connections, the circuit is closed for a moment and the rheostat is adjusted for a suitable current, say 1 ampere, in the ammeter. The circuit is kept open, the cathode plate is removed and cleaned with emery sheet. It is then washed in water, dried and its mass  $m_1$  is determined accurately using a digital balance.

The cathode plate is then fixed in its position and the circuit is closed, simultaneously starting a stopwatch. The current is passed for 30 minutes and during the passage of current the ammeter value should be maintained as the same.

After 30 minutes the cathode is taken out, rinsed with water, dried and its mass  $m_2$  is found accurately. The time of passage of current is noted. The mass of copper deposited is determined and hence e.c.e. of copper is calculated using the given formula.

### **Result:**

The electro chemical equivalent of copper  $Z =$   $\text{kg C}^{-1}$



### Observation:

Mass of the cathode before passing current	$m_1$	=	g
		=	kg
Mass of the cathode after passing current	$m_2$	=	g
		=	kg
Mass of the copper deposited at cathode	$m$	=	$(m_2 - m_1)$
	$m$	=	kg
Current flowing through the electrolyte (Ammeter reading)	}		$I$ = A
Time of passage of current	$t$	=	minutes
		=	second

### Recording of time of passage of current (in minutes):

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

### Calculation:

The electro chemical equivalent of copper

$$Z = \frac{m}{It} = \frac{m_2 - m_1}{It}$$

$$=$$

$$= \text{kg C}^{-1}$$

## CHARACTERISTICS OF P-N JUNCTION DIODE

**Experiment No.:**

**Date:**

**Aim:**

To draw the voltage - current characteristics of a P-N Junction diode in forward bias and to find the 'dynamic forward resistance' and 'knee voltage' from the graph

**Apparatus required:**

P-N junction diode (Germanium or Silicon), D.C. power supply (0 - 10 V), D.C. milliammeter (0 – 15 mA), D.C. Voltmeter (0 – 1.5 V), resistance (500 ), etc.

**Formula:**

The dynamic forward resistance  $r = \frac{\Delta V}{\Delta i}$   
where

$\Delta V$  = a small change in potential difference (p.d) applied to the diode

$\Delta i$  = the corresponding change in the current flowing through the diode

Knee voltage ( $V_k$ ): It is the approximate voltage above which the diode current increases sharply.

**Theory:**

When the positive terminal of the battery is connected to P-type and negative terminal to N-type of a semiconductor diode, current flows easily through the diode. Now it is said to be in forward bias.

When the P-type material is connected to negative and N-type to positive of the battery, the diode offers a high impedance path and little current flows through the diode. Now it is said to be in reverse bias.

This property of P-N Junction diode, allowing the flow of current in one direction easily is made use of in many electronic circuits, especially in solid state half-wave and full-wave rectifiers.

**Procedure:**

The anode and cathode of a P-N junction diode can be identified by seeing a colour band or spot on the cathode. Also the cathode may be having pointed edge in some type.

For forward biasing, the connections are given neatly as shown in the diagram. Suitable ranges of meters, resistance and power supply can be selected.

The current flowing through the diode is noted for various values of p.d. applied across the diode and the readings are noted in the tabular column. With these readings, a neat graph is drawn by taking forward voltage applied across the diode in X - axis and forward current flowing through the diode (in mA) along Y - axis.

This curve is called as the forward characteristics of the diode. From this graph, the approximate voltage above which the diode current sharply increases, can be determined, which gives the "Knee Voltage" of the diode.

For germanium diode, the knee voltage is 0.3 volt and for silicon diode the knee voltage is 0.7 volt, which is almost equal to the barrier potential.

In the upper region of the curve, two perpendicular lines OA and AB are drawn to find the dynamic forward resistance, as shown in the model graph. In this OA gives the value of small change in p.d. applied across the diode ( $\Delta v$ ) and AB gives the corresponding change in the current flowing through the diode ( $\Delta i$ ). These values are determined.

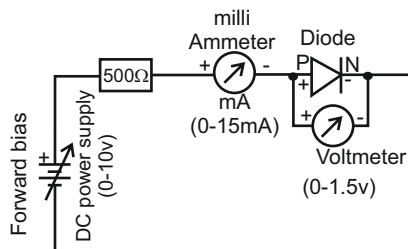
Then the dynamic forward resistance of the diode is determined by using the given formula.

**Result:**

The forward characteristics of a P-N Junction diode is drawn.

From the graph,

- (i) The dynamic forward resistance  $r =$                   ohm
- (ii) The knee voltage         $V_k =$                   volt



Circuit diagram for drawing the forward characteristics of P-N junction diode.

**Tabular column:**

Readings for drawing the forward characteristics of P-N junction diode

Sl. No.	P.d applied across the diode (v)		Current flowing through the diode (i)	
	div	volt	div	milliampere (mA)
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				

**Calculation:**

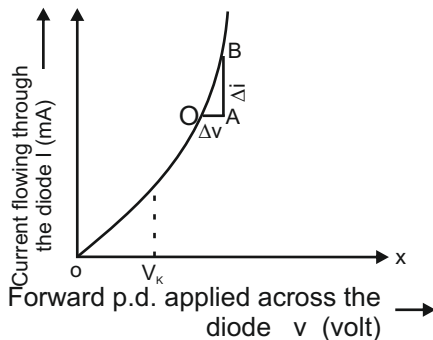
From graph,

$$\Delta V = \quad \text{div} ; \quad \Delta i = \quad \text{div}$$

For calculating  $\Delta V$  in volt

$$\text{In X-axis } 10 \text{ div} = \quad \text{volt} ; 1 \text{ div} = \quad \text{volt}$$

$$\therefore \Delta V = \quad \text{div} = \quad \times \quad = \quad \text{volt}$$



For calculating  $\Delta i$  in mA

$$\begin{aligned} \text{In Y-axis } 10 \text{ div} &= \text{mA} ; 1 \text{ div} = \text{mA} \\ \therefore \Delta i &= \text{div} = x = \text{mA} \\ &= x \times 10^{-3} \text{ A} \end{aligned}$$

(i) The dynamic forward resistance is  $r = \frac{\Delta v}{\Delta i} =$

$$= \text{ohm}$$

(ii) The knee voltage is  $V_k =$  div  
 $= x$   
 $= \text{volt}$

## LOGIC GATES

**Experiment No.**

**Date:**

**Aim:**

To find the output condition for different combinations of the inputs for NOT gate and two inputs AND, OR, NAND and NOR logic gates, using IC Chips.

**Apparatus required:**

Logic gate apparatus kit with chip mounting base, integrated circuit chips (IC chips) for the above logic gates.



**Description:**

The logic gate kit consists of required DC power supply, light emitting diodes (LEDs), to indicate the input and the output signal, toggle switches to provide various combinations of input and breadboard to mount the desired IC chip.

In the kit when the LED glows, the corresponding condition is “ON”, and the binary is 1. If the LED does not glow the corresponding condition is “OFF”, and the binary is 0.

**Procedure:****(a) NOT gate:**

It is the simplest form of the logic gates. It has only one input and one output. The function of this gate is to produce one logic level from the opposite logic level. i.e. If the input condition is “ON”, the output condition will be “OFF” and if the input condition is “OFF”, the output condition will be “ON”.

The NOT gate is available in IC chip number 7404. The pin configuration for the power supply, ground, input and output of the IC chip is given in the figure and the Boolean expression is also given.

The 7404 IC is mounted on the base provided in the kit. Suitable input level is given and the corresponding output level is noted in the truth table of NOT gate.

The function of this gate is inverting or complementing the input signal. So, this gate is also called as a 'Complementer or Inverter gate'.

**(b) AND gate:**

This gate has two or more inputs and only one output. The function of this gate is to produce a true condition on its output, if and only if all its input conditions are true. i.e., the output of the gate is in “ON” condition if and only if all its inputs are in “ON” condition.

The two inputs AND gate is available in IC chip number 7408. The pin configuration for the power supply, ground, input and output of the IC chip is given in the figure and the Boolean expression is also given.

The 7408 IC is mounted on the base provided in the kit. Suitable combinations of input levels are given and the corresponding output levels are noted in the truth table of AND gate.

This gate is also called as a 'Multiplier gate'.

**(c) OR gate:**

This gate has two or more inputs and only one output. The function of this gate is to produce the true condition on its output, when one or more of its input conditions are true. i.e., The output of the gate is in “ON” condition if any one of its inputs is in “ON” condition.

The two inputs OR gate is available in IC chip number 7432. The pin configuration for the power supply, ground, input and output of the IC chip is given in the figure and the Boolean expression is also given.

The 7432 IC is mounted on the base provided in the kit. Suitable combinations of input levels are given and the corresponding output levels are noted in the truth table of OR gate.

This gate is also called as a 'Adder gate'.

These above three gates are called 'Basic Gates'.

**(d) NAND gate:**

It is a combination of AND and NOT gates. The output of NAND gate is complementation of that of an AND gate.

The two inputs NAND gate is available in IC chip number 7400. The pin configuration for the power supply, ground, input and output of the IC chip is given in the figure and the Boolean expression is also given.

The 7400 IC is mounted on the base provided in the kit. Suitable combinations of input levels are given and the corresponding output levels are noted in the truth table of NAND gate.

**(e) NOR gate:**

This gate is a combination of NOT and OR gates. The output of the NOR gate is Complementation of that of an OR gate.

The two inputs NOR gate is available in IC chip number 7402. The pin configuration for the power supply, ground, input and output of the IC chip is given in the figure and the Boolean expression is also given.

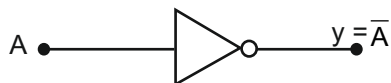
The 7402 IC is mounted on the base provided in the kit. Suitable combinations of input levels are given and the corresponding output levels are noted in the truth table of NOR gate.

These above two gates are known as 'Universal gates'.

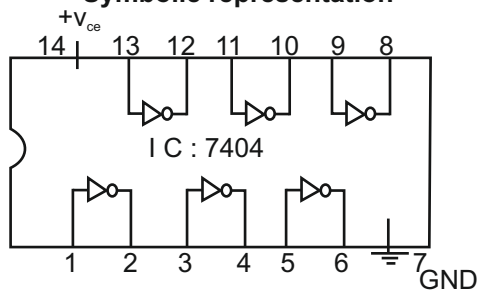
**Result:**

Thus the output condition for different combinations of the inputs for NOT gate and two inputs AND, OR, NAND and NOR logic gates are noted in the truth table.

a) NOT gate:



**Symbolic representation**



**NOT gate IC chip**

IC No: 7404

Pin configuration:

Input pins : 1,3,5,9,11,13

Output pins: 2,4,6,8,10,12

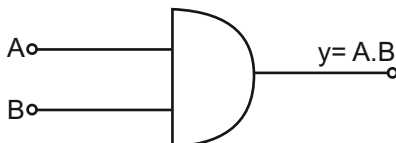
Ground pin : 7

Power pin ( $+V_{cc}$ ): 14

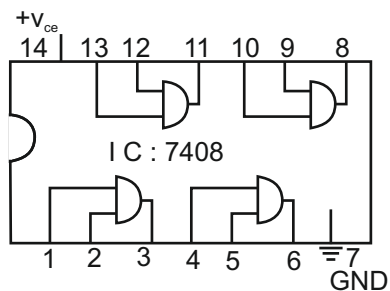
**Truth table for NOT gate**

INPUT	OUTPUT
A	$Y = \bar{A}$
0	
1	

b) AND gate:



**Symbolic representation**



**Two input AND gate IC chip**

IC No: 7408

Pin configuration:

Inputpins : 1,2,4,5,9,10,12,13

Output pins : 3,6,8,11

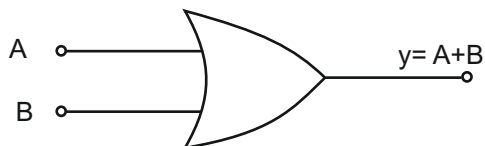
Ground pin : 7

Power pin (+  $V_{cc}$ ): 14

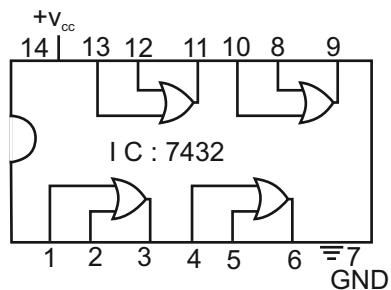
**Truth table for AND gate**

INPUTS		OUTPUT $Y = A.B$
A	B	
0	0	
0	1	
1	0	
1	1	

**c) OR gate:**



**Symbolic representation**



**Two input OR gate IC chip**

IC No: 7432

Pin configuration:

Input pins: 1,2,4,5,9,10,12,13

Output pins: 3,6,8,11

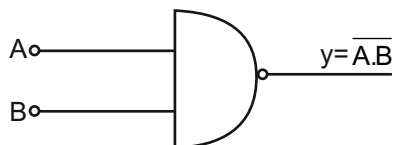
Ground pin : 7

Power pin (+  $V_{cc}$ ): 14

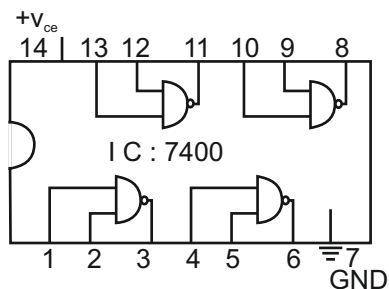
**Truth table for OR gate**

INPUTS		OUTPUT $Y = A + B$
A	B	
0	0	
0	1	
1	0	
1	1	

**d) NAND gate:**



**Symbolic representation**



**Two input NAND gate IC chip**

IC No: 7400

Pin configuration:

Input pins: 1, 2, 4, 5, 9, 10, 12, 13

Output pins: 3, 6, 8, 11

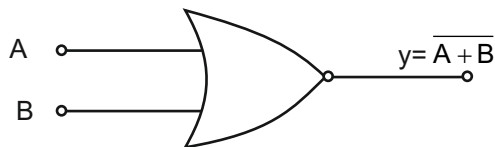
Ground pin : 7

Power pin ( $+V_{cc}$ ): 14

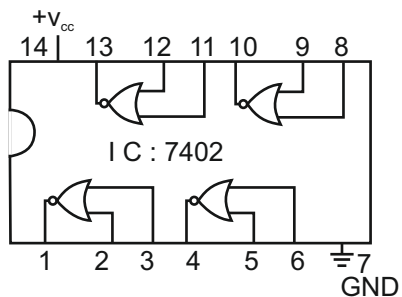
**Truth table for NAND gate**

INPUTS		output $y = \overline{A \cdot B}$
A	B	
0	0	
0	1	
1	0	
1	1	

**e) NOR gate:**



**Symbolic representation**



**Two input NOR gate IC chip**

IC No: 7402

Pin configuration:

Input pins: 2, 3, 5, 6, 8, 9, 11, 12

Output pins: 1, 4, 10, 13

Ground pin : 7

Power pin ( $+V_{cc}$ ): 14

**Truth table for NOR gate**

INPUTS		output $y = \overline{A + B}$
A	B	
0	0	
0	1	
1	0	
1	1	

## MODEL QUESTION PAPER

1. Determine the refractive index of the given transparent liquid using traveling microscope.
2. Draw the  $V - I$  characteristics of the solar cell.
3. Measure the angle of the prism and the angle of minimum deviation using spectrometer and then calculate the refractive index of glass.
4. Verify the laws of resistances by connecting the two given standard resistances (i) in series and (ii) in parallel, using Ohm's law.
5. Determine the unknown resistance of the given wire, using metre bridge.
6. Compare the electro motive forces (e.m.f.s) of the given two cells, using potentiometer.
7. Determine the specific heat capacity of water, using Joule's calorimeter.
8. Determine the electro chemical equivalent (e.c.e.) of copper using Copper Voltameter.
9. Draw the voltage – current characteristics of a P-N junction diode in forward bias and then find the 'dynamic forward resistance' & 'knee voltage' from the graph.
10. Find the output conditions for different combinations of the input for NOT gate (7404) and 2 inputs AND, (7408) OR, (7432) NAND (7400) & NOR (7402) logic gates using IC chips.