FACTORS AFFECTING THE INTERNAL RESISTANCE OF A CELL

INTRODUCTION

When charges flow through an electrolyte of the cell, the electrolyte offers some resistance to the flow of charges. this resistance, which the electrolyte offers, is called the internal resistance of the cell.

INTERNAL RESISTANCE

let us consider a simple circuit consisting of an external resistance (R), connected to a source of emf (E) that has an internal resistance (r). let (I be the current flowing through the circuit and let V be the potential difference across the ends of the resistor

When a current I flows through the sources, the latter does work to transfer the charge from one end to the other. If E is the EMF of the cell, r is the internal resistance, then a part v of E is used up to transfer charge from one end to another

According to Ohm's law $v = Ir$ — ① .

The remaining part $V = E - v$ drives the charge through the external resistance R

$V = IR$ — ②

$$E = V + v \quad \text{--- (3)}$$

From (1) (2) and (3)

$$E = IR + Ir$$

$$E = I(R + r)$$

$$\boxed{I = \frac{E}{R + r}}$$

Again,

$$E = IR + Ir$$

$$= V + Ir$$

$$Ir = E - V$$

$$\boxed{r = \frac{(E - V)}{V} R}$$

DETERMINING INTERNAL RESISTANCE

A potentiometer is a device used to determine the internal resistance of a cell. It consists of a uniform resistance wire (usually 10m long) kept stretched on a wooded board by the side of a meter scale. A jockey that slides over the wires can make contact with any point on the wire

Consider a cell of emf E is the primary circuit that supplies a steady current (I) Let AB is the potentiometer wire. The cell of emf (E) whose internal resistance (r) is to be determined a resistance box R and galvanometer (G) are connected.

The balancing length L_1 is obtained without connecting the resistance box (R) in the circuit

Hence we obtain the relation $E = i\rho L_1$ —①

where ρ is the resistance per unit length.

Let L_2 be the balancing length when resistance box (R) is connected in parallel with the cell. Hence,

$$V = i\rho L_2 \quad \text{—②}$$

$$\frac{E}{R+r} = i\rho L_2 \quad \text{—③}$$

Dividing ① by ②

$$\frac{E}{V} = \frac{L_1}{L_2} \quad \text{—④}$$

We have $E = I(R+r)$

Also, $V = IR$

$$\therefore \frac{E}{V} = \frac{R+r}{R}$$

$$\frac{E}{V} = 1 + \frac{r}{R}$$

Substituting in ④

$$\frac{E}{V} = \frac{L_1}{L_2} = 1 + \frac{r}{R}$$

$$\boxed{r = \frac{(L_1 - L_2)R}{L_2}}$$

FACTORS ON WHICH INTERNAL RESISTANCE OF A CELL DEPENDS

Three experiments have been conducted to study the factors that influence the internal resistance of a primary cell.

Objective : To study the factors on which the internal resistance of a cell depends. They are

1) Separation between electrodes of the cell
2) Size or area of electrode
3) Temperature of the electrolyte

Apparatus Required : Ten wire potentiometer, Resistance box, Rheostat, Two-one way-keys, Standard batteries, primary cells, galvinometer, water bath, Burner, Tripod stand and wire gauze.

Procedure:

1) Effect on internal resistance due to separation between electrodes.

Connect the battery across the potentiometer wire through the rheostat and key with the positive terminal connected to A. Take the primary cell whose internal resistance is to be determined and connect the positive terminal to A and negative terminal to the galvinometer. The other terminal of the galvanometer is connected to a jockey. Now connect the resistance box (R) in parallel with the primary cell through a key. Check the connections before starting the experiment.

After doing so, insert a plug in the key in the main circuit (K_1) so that the current flows in the potentiometer and determine the null point. Remove the shunt and obtain the exact null point. this no current flows through the galvanometer and thus the deflection shown by a galvanometer is zero. Now measure the balancing

Effect of concentration of electrolyte on the internal resistance

Concentration = 250 ml							
Resistance	Balancing length (L_1)			Balancing length (L_2)			Internal Resistance
	1	2	Mean	1	2	Mean	
6	580	562	581	599	403	401	2.69
8	582	586	584	440	439	439.5	2.63
10	587.2	590	588.2	440.5	449	443.9	3.26
						Mean	2.87 Ω

Concentration = 300ml							
Resistance	Balancing Length (L_1)			Balancing length (L_2)			Internal resistance
	1	2	Mean	1	2	Mean	
6	594	593	593.5	355	352.5	352	4.35
8	579	586	582.5	403	406	404	4.24
10	581.5	585	583.75	384	383	383.5	4.18
						Mean	4.21 Ω

Concentration = 350 ml							
Resistance	Balancing length (L_1)			Balancing length (L_2)			Internal Resistance
	1	2	Mean	1	2	Mean	
6	582	682	582	338	337	337.5	4.17
8	581	581	581	359	368	368.5	4.41
10	576	577	576.5	367	369	348	4.53

Effect of temperature of electrolyte on the internal resistance

Temperature = 55 degree celsius

Resistance	Balance length (L_1) 1	Balance length (L_1) 2	Balance length (L_1) Mean	Balance length (L_2) 1	Balance length (L_2) 2	Balance length (L_2) Mean	Internal resistance
6	595.5	595.5	595.5	417	413	415	1.96
7	587.5	590	588.75	434	434.5	434.25	2.3
8	596	597	596.5	486	487	486.5	1.81
						Mean	2.01 Ω

Temperature = 45 degree celsius

Resistance	Balance length (L_1) 1	Balance length (L_1) 2	Balance length (L_1) Mean	Balance length (L_2) 1	Balance length (L_2) 2	Balance length (L_2) Mean	Internal resistance
6	593.5	592.5	593	448.5	447.5	448	2.61
7	593	593	593	445	447	446	2.49
8	587	597	592	453	453	453	2.4
						Mean	2.5 Ω

Temperature 35 degree celsius

Resistance	Balancing length (L_1) 1	Balancing length (L_1) 2	Balancing length (L_1) Mean	Balancing length l_2 1	Balancing length l_2 2	Balancing length l_2 Mean	Internal resistance
6	600	601	600.5	367	367	367	3.81
7	583	588	588.5	405	404	404.5	3.13
8	590	593	591.5	431	433	432	2.95
						Mean	3.29 Ω

length, L_1.

Now insert a plug in the key (K_2) and take out a certain resistance from the resistance box and determine the exact balance point. Measure the balancing length, L_2 and record the observations.

After the final reading is taken, verify the separation between the electrodes of the primary cell and measure the internal resistance in each case.

2) Effect of the size of the electrodes on the internal resistance of the cell.

In this case, keep the separation between the electrodes of the primary cell constant and vary the size (area) of the electrodes in contact with the electrolyte. Measure the internal resistance of the cell in each case. Plot a graph b/w ~~in each~~ the size of electrode and observed value of internal resistance of primary cell

3) Effect of temperature of electrolyte.

Keep the primary cell in a water bath and heat the electrolyte. Determine the internal resistance of the cell at different temperatures. Plot a graph between temperature of electrolyte and internal ~~resis~~ resistance of the primary cell. Interpret the graph. Take observations of atleast 2 primary cells.

Special instructions:

1) The cell whose internal resistance is to be obtained should not be distributed during the experiment.

2) The contact between the jockey and potentiometer should be momentary.

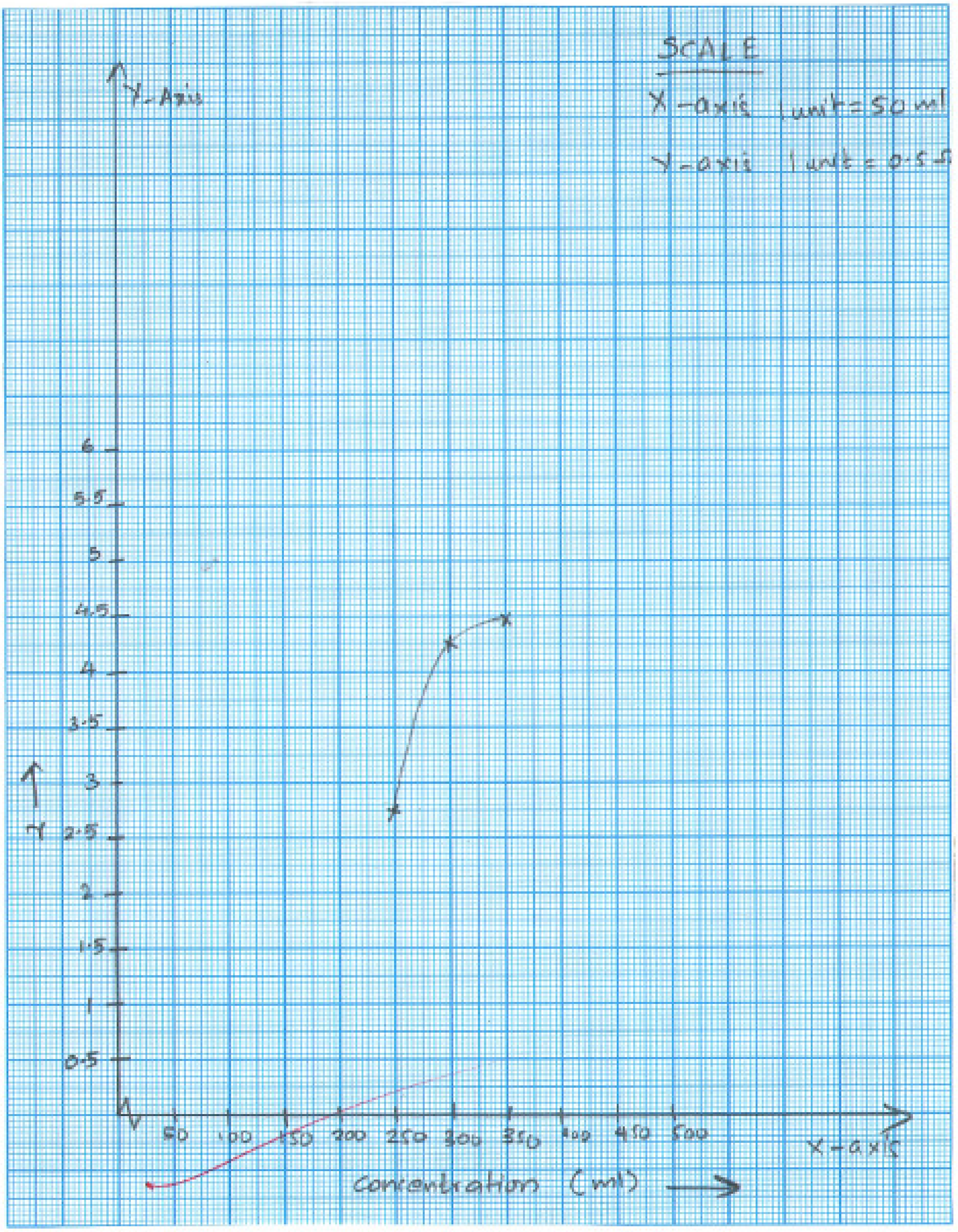
3) The battery in the main circuit must possess a constant EMF.

Factors that may affect the result

1) Any error in the battery length of the wire will affect the result.

2) Approximation in detecting the null deflection will affect the result.

VARIATION OF INTERNAL RESISTANCE WITH CONCENTRATION.



VARIATION OF INTERNAL RESISTANCE WITH TEMPERATURE