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EXPERIMENT- 8

Title:- Variation of Nernst equation using Daniel cell.

Aim:- To test the effect of concentration of Cu^{2+} ion of the E_{cell} .

Principles:- Daniel cell is formed by Zn^{2+}/Zn and Cu^{2+}/Cu half cells.

Potential difference between the two electrodes anode and cathode in an electrochemical cell is expressed by Nernst equation.

$$E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{RT}{nf} \log Q$$

$$\therefore \log Q = \frac{[\text{Zn}^{2+}]}{[\text{Cu}^{2+}]}$$

$$E_{\text{cell}} = E_{\text{cell}}^{\circ} - 2.303 \frac{RT}{nf}$$

$E_{\text{cell}}^{\circ} = 1.10\text{V}$ for standard free state.

S.No	Concentration of Zn^{2+}	Concentration of Cu^{2+}	$Q = \frac{[\text{Zn}^{2+}]}{[\text{Cu}^{2+}]}$
1	1.0 M	1.0 M	$= \frac{1}{1} = 1$
2	1.0 M	0.1 M	$= \frac{1}{0.1} = 10$
3	1.0 M	0.01 M	$= \frac{1}{0.01} = 100$
4	1.0 M	0.001 M	$= \frac{1}{0.001} = 1000$

Concentration of Cu^{2+}	E_{cell} (V)
1.0 M	1.079
0.1 M	1.048
0.01 M	1.037
0.001 M	1.018
Unknown	1.054

Calculation:

Concentration of Cu^{2+} unknown Solution

$$E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{RT}{nf} \log Q$$

$$\therefore n=2, T=25^{\circ}\text{C}, [\text{Cu}^{2+}] = 1\text{M}$$

$$E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{8.314 \times 298}{2 \times 96500} \ln Q$$

$$1.054 = 1.10 - 0.0128 \ln \left(\frac{1}{[\text{Cu}^{2+}]} \right)$$

$$\ln \left(\frac{1}{[\text{Cu}^{2+}]} \right) = 3.593$$

$$\frac{1}{[\text{Cu}^{2+}]} = e^{3.593} = 36.34$$

$$[\text{Cu}^{2+}] = 0.027\text{M}$$

Result:

① Unknown Solution Concentration of $[\text{Cu}^{2+}]$ is 0.027 moles.

$$\therefore \text{Slope} = 0.02$$

Answers for Questions:-

- ① The E_{cell} decreases with increase in molar concentration of Zn^{2+} . The E_{cell} increases with increase in molar concentration of Cu^{2+} .
- ② 1.10 V
- ③ change in Gibbs free energy for this reaction is $-3886.4092 \text{ J K}^{-1} \text{ mol}^{-1}$

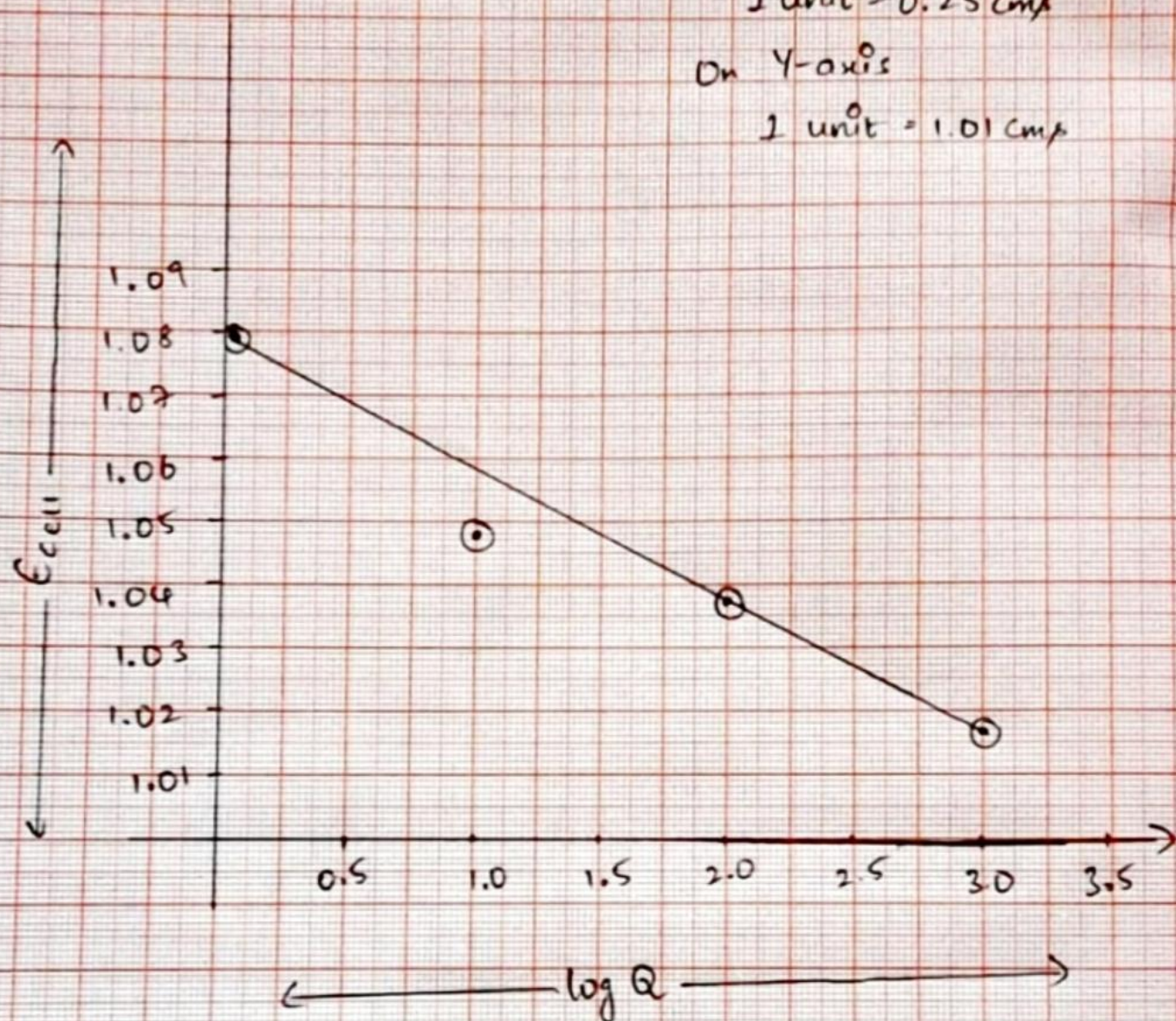
Scale

On x-axis

1 unit = 0.25 cm

On y-axis

1 unit = 1.01 cm



$$\text{Slope} = \frac{-RT}{nF} = \frac{-0.0592}{n} = \frac{-0.0592}{2}$$

$$\therefore \text{Slope} = -0.02$$