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Experiment no: 04

Name of the Experiment: Determination of the resistance of a galvanometer by half deflection method.

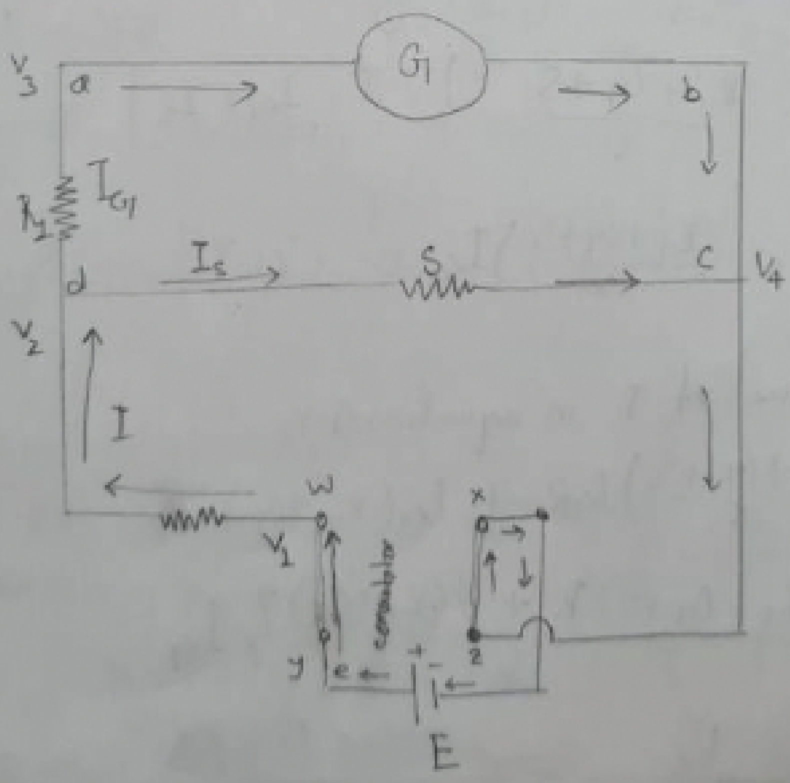
Questions on theory (all diagrams should be drawn by using a pencil and a scale)

*1) What is resistance of the galvanometer? [0.25]

Ans: Resistance of galvanometer is the resistance of a coil of wire wound over a rectangular frame kept in a magnetic field inside the galvanometer

*2) Draw the circuit diagram for this experiment. [0.25]

Ans:



*3) Derive an expression for the current passing through the galvanometer as a function of the resistances of the shunt box, two resistance boxes and the emf of the voltage source, i.e., equation (8). [2]

Ans: Using kirchoff's loop voltage rule in the circuit diagram's adabcde loop,

$$IR + I_G R_1 + I_G G - E = 0$$

$$\Rightarrow E = IR + I_G(R_1 + G) \cdots \text{(i)}$$

Using kirchoff's loop voltage rule in closed loop abcda,

$$I_G R_1 + I_G G - I_s S = 0$$

$$\Rightarrow I_s S = I_G(R_1 + G)$$

$$\Rightarrow \frac{I_s}{I_G} = \frac{R_1 + G}{S}$$

$$\Rightarrow \frac{I_s + I_G}{I_G} = \frac{R_1 + G + S}{S}$$

$$\Rightarrow \frac{I}{I_G} = \frac{R_1 + G + S}{S} \quad [\because I = I_G + I_s]$$

$$\therefore I = \left(\frac{R_1 + G + S}{S}\right) I_G \cdots \text{(ii)}$$

Pluging in the value of I in equation (i):

$$E = \left(\frac{R_1 + G + S}{S}\right) I_G R + I_G(R_1 + G)$$

$$= \left\{\frac{(R_1 + G + S)R + S(R_1 + G)}{S}\right\} I_G$$

$$I_G = \frac{ES}{(R_1 + G + S)R + S(R_1 + G)}$$

*4) Show that, the value of R_1 for which the galvanometer's deflection is reduced down to the half of the deflection when $R_1 = 0$, is approximately equal to the galvanometer's resistance. [2]

Ans: We know,

Deflection angle of the galvanometer's pointer θ is proportional to the current passing through the galvanometer, I_G

$\therefore \theta \propto I_G$

$\Rightarrow \theta = \frac{1}{k} I$

$I_G = k\theta$ [k = Galvanometer's constant]

If $R_1 = 0$

$$\frac{Es}{RG + RS + GS} = k\alpha \quad \ldots (i)$$

When Galvanometer's deflection is reduced down to the half deflection

$$\frac{Es}{(R_1 + G + S)R + S(R_1 + G)} = \frac{k\alpha}{2} \quad \ldots (ii)$$

(i) ÷ (ii) ⇒

$$\frac{(R_1 + G + S)R + S(R_1 + G)}{RG + RS + GS} = 2$$

$$\Rightarrow \frac{(RG + RS + GS) + RR_1 + R_1S}{RG + RS + GS} = 2$$

$$\Rightarrow 1 + \frac{RR_1 + R_1S}{RG + RS + GS} = 2$$

As S is very much smaller than R and G we can neglect the terms containing S in the equation

$\therefore R_1 \simeq G$

5) For a certain value of shunt-resistance, S and ... deflection of the galvanometer is shown in Figure A.

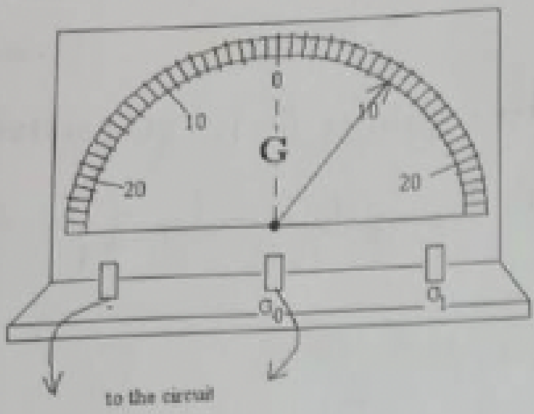
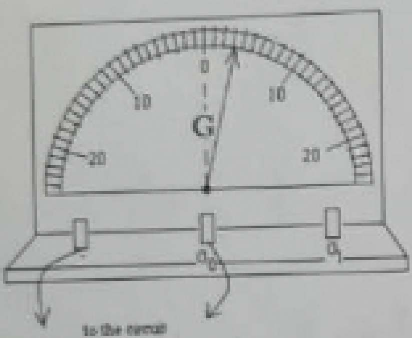
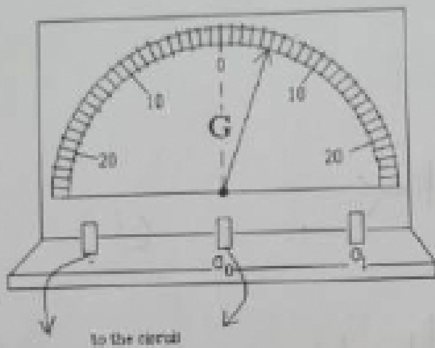


Figure A: Deflection when $R_1 = 0$

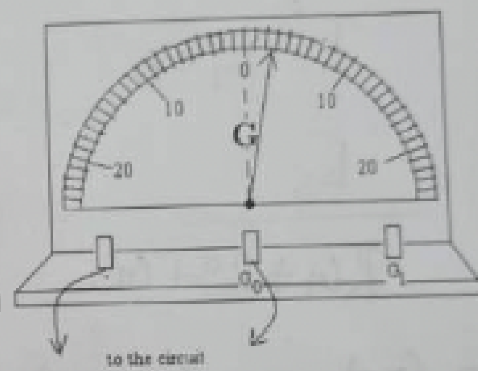
By keeping S and R fixed the deflections of the galvanometer for different values of R_1 are shown in the following figures.



when $R_1 = 6\ \Omega$



when $R_1 = 3\ \Omega$



when $R_1 = 9\ \Omega$

What is the internal resistance of the galvanometer? [0.5]

Ans: $R_1 = 6\Omega$

$1 + R/G = \frac{\theta_1}{\theta_2}$ ⇐ deflection

$1 + R/G = \frac{10}{3}$

$\Rightarrow \frac{6}{G} = 7/3$

$\Rightarrow G = \frac{6\times 3}{7}$

$\therefore G = 2.57\Omega$

when $R_1 = 3\Omega$,

$1 + R/G = 10/5$

$\therefore R/G = 1 \Rightarrow R = G = 3\Omega$

When $R_1 = 9\Omega$

$1 + R/G = \frac{10}{2.5}$

$R/G = 4.1$

$G = 3\Omega$

$\therefore$ internal resistance $= \frac{3+3+2.57}{3}$

$= 2.92\Omega$

$\cong 3\Omega$

- Draw the data table(s) and write down the variables to be measured shown below (in the 'Data' section), using pencil and ruler BEFORE you go to the lab class.

- Write down your NAME and ID on the top of the page.
- This part should be separated from your Answers of "Questions on Theory" part.
- Keep it with yourself after coming to the lab.

Data

Table: Data for determining the resistance of a galvanometer

No. of observation	R (Ω)	S (Ω)	Flow of current	Deflection when $R_1=0$ (θ_0)	$R_1(\neq 0)$ (Ω)	Deflection when $R_1 \neq 0$ (θ)	$G \approx R_1 / \left(\frac{\theta_0}{\theta}-1\right)$ (Ω)	Mean G (Ω)
1	50	.2	D	43	100	2 1.5	100	110.333
			L	4	120	1.5 2	120	
2	20	.2	D	8	140	4	140	
			L	9	140	4.5	140	
3.	20	.3	D	12	120	6	120	
			L	10	100	5	100	
4	50	.3	D	4	120	2	120	
			L	6	110	3	110	
5	30	.2	D	5	110	2.5	110	
			L	5	70	2.5	70	
6	30	.3	D	6	100	3	100	
			L	6	100	3	100	

- READ the PROCEDURE carefully and perform the experiment by YOURSELVES. If you need help to understand any specific point draw attention of the instructors.
- DO NOT PLAGIARIZE data from other group and/or DO NOT hand in your data to other group. It will bring ZERO mark in this experiment. Repetition of such activities will bring zero mark for the whole lab.
- Perform calculations by following the PROCEDURE . Show every step in the Calculations section.
- Write down the final result(s)

Calculations

Results: