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Case Study Report

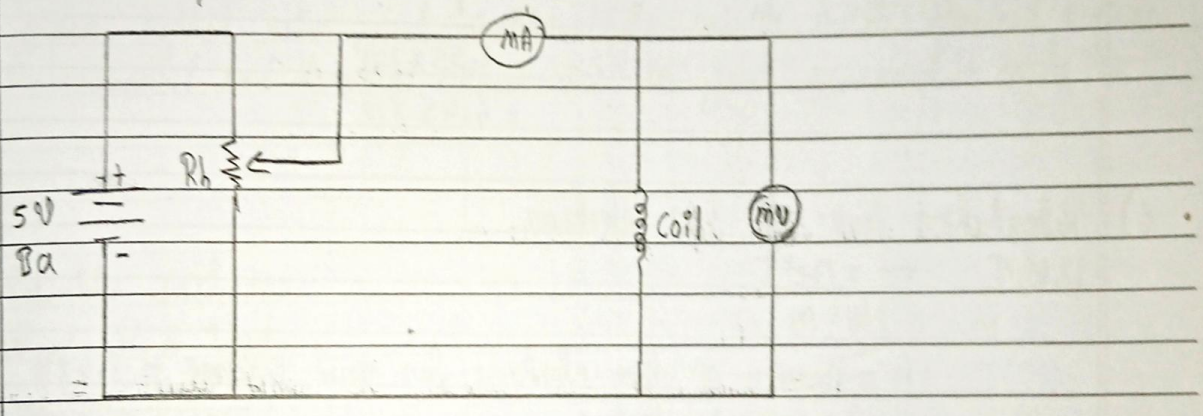
Problem Statement: Study the Electrical properties of given copper coil

Parameters and formulae studied

1) Diameter of wire measured using screw gauge (d) = 0.58 mm
2) Length of the wire given 5.1 m
3) Cross section area $A = \frac{\pi d^2}{4} = \frac{3.142 \times (0.58 \times 10^{-3})^2}{4} = 2.64 \times 10^{-7} m^2$
4) Resistivity of the given copper wire $\rho = \frac{RA}{l}$ Ωm

Experimental determination of resistance:

Circuit Diagram:



Tabular Column:

S.I No	Voltage 'V' (in mV)	Current 'I' (in mA)	Resistance 'R' (in Ω)
1	30	1.0	30.00
2	35	1.13	30.97
3	40	1.38	28.98
4	45	1.52	29.60
5	50	1.69	29.58
6	55	1.80	30.55
7	60	1.98	30.30

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8	65	2.16	30.09
9	70	2.35	29.78
10	75	2.52	29.76

$\therefore M = 29.96$

$\therefore$ Experimental value of resistance of the coil $R = 29.96$

Hence $\rho = \frac{RA}{l}$

$= \frac{29.96 \times 2.64 \times 10^{-7}}{5.10}$

$= 1.55 \times 10^{-6}\ \Omega m$

5) Conductivity of copper wire $\sigma = \frac{1}{\rho}$

$= \frac{1}{1.55 \times 10^{-6}}$

$= 6.45 \times 10^{5}$

6) Relaxation time of free electron

W.K.T $\sigma = \frac{ne^2\tau}{m}$

n = number of free electrons per unit volume $= 8.4 \times 10^{28}\ /m^3$

m = mass of electron $= 9.1 \times 10^{-31}\ kg$

e = charge of electron $= 1.6 \times 10^{-19}\ C$

$\tau = \frac{\sigma m}{ne^2}$

$= \frac{6.45 \times 10^5 \times 9.1 \times 10^{-31}}{8.4 \times 10^{28} \times (1.6 \times 10^{-19})^2}$

$\tau = 2.72 \times 10^{-16}\ s$

7) Mobility of an electron $= \mu = \frac{e\tau}{m}$

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$$\mu = \frac{1.6\times10^{-19}\times2.72\times10^{-16}}{9.1\times10^{-31}}$$

$$\mu = 4.78\times10^{-5}$$

e) Drift Velocity:

$$v_d = \frac{I}{neA}$$

$$= \frac{2.52\times10^{-3}}{8.4\times10^{28}\times1.6\times10^{-19}\times2.64\times10^{-7}}$$

$$= 7.10\times10^{-7}\ m/s.$$

Conclusion: A wire of 5.10 m was given to study the electrical properties and we have studied above eight properties of the given copper wire and compared the results with standard values. Experimental and theoretical values are in good agreement to each other

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