CHAPTER-3 CURRENT ELECTRICITY

* NCERT EXCERSISE :

1. Emf of the battery, $r = 0.4\,\Omega$
Maximum Current Drawn = I
According to Ohm's law

$E = Ir$

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

$\Rightarrow \frac{12}{0.4} = 30A$

2. Emf, $E = 10V$
Internal Resistance, $r = 3\,\Omega$
$I = 0.5A$
Resistance = R

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

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

$= \frac{10}{0.5} = 20\,\Omega$

$R = 17\,\Omega$
$r = 3\,\Omega$

$V = IR$
$= 0.5 \times 17$
$= 8.5V$

3 a Three resistors of resistance

$$R = 1\Omega + 2\Omega + 3\Omega$$
$$= 6\Omega$$

b $= I = \frac{E}{R}$

$$= \frac{12V}{6\Omega} = 2A$$

$V_1 = 2 \times 1 = 2V$

$V_2 = 2 \times 2 = 4V$

$V_3 = 2 \times 3 = 6V$

4 a $R = \frac{1}{2} + \frac{1}{4} + \frac{1}{5}$

$$= \frac{10 + 5 + 4}{20} = \frac{19}{20} = \frac{20}{19}\Omega$$

b Emf $= 20V$

$I_1 = \frac{V}{R} = \frac{20}{20} = 10A$

$I_2 = \frac{V}{R} = \frac{20}{4} = 5A$

$I_3 = \frac{V}{R} = \frac{20}{5} = 4A$

$I_{tot} = I_1 + I_2 + I_3 = 19A$

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5 $T = 27^\circ C$

$R = 100\,\Omega$

$T_1 = ?$

$R_1 = 117\,\Omega$

$\alpha = 1.70 \times 10^{-4}\,{}^\circ C^{-1}$

$$\alpha = \frac{R_1 - R}{R(T_1 - T)}$$

$$T_1 - T = \frac{R_1 - R}{R\alpha}$$

$$T_1 - 27 = \frac{117 - 100}{100(1.7 \times 10^{-4})}$$

$T_1 - 27 = 1000$

$T_1 = 1027^\circ C$

6 $l = 15\,m$

$a = 6.0 \times 10^{-7}\,m^2$

$R = 5.0\,\Omega$

$\rho = ?$

$$R = \rho \frac{l}{A}$$

$$\rho = \frac{RA}{l} = \frac{5 \times 6 \times 10^{-7}}{15} = 2 \times 10^{-7}\,\Omega m$$

7 $R_1 = 2.1\,\Omega$

$T_1 = 27.5^\circ C$

$R_2 = 2.7\,\Omega$

$T_2 = 100^\circ C$

$$\alpha = \frac{R_2 - R_1}{R_1(t_2 - t_1)} = \frac{2.7\,\Omega - 2.1\,\Omega}{2.1\,\Omega\,(100 - 27.5)} = 0.0039^\circ C^{-1}$$

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8 $V = 230V$

$I_1 = 3.2A$

$R_1 = \frac{V_1}{I} = \frac{230}{3.2} = 71.87\ \Omega$

$I_2 = 2.8A$

$R_2 = \frac{230}{2.8} = 82.14\ \Omega$

$\alpha = 1.70 \times 10^{-4}\ {}^{\circ}C^{-1}$

$T_1 = 27^{\circ}C$

$T_2 = ?$

$\alpha = \frac{R_2 - R_1}{R_1(t_2 - t_1)} \Rightarrow T_2 - 27^{\circ}C = \frac{82.14 - 71.84}{71.87 \times 1.7 \times 10^{-4}}$

$T_2 = 840.5 + 27 = 867.5^{\circ}C$

10 Q

a $l_1 = 39.5\ cm$

$R = 12.5\ \Omega$

$\frac{X}{Y} = \frac{100 - l_1}{l_1}$

$= \frac{100 - 39.5}{39.5} \times 12.5 = 8.2\ \Omega$

$X = 8.2\ \Omega$

b If x and y are interchanged then l_1 and $100 - l_1$ get interchanged

$100 - l_1 = 100 - 39.5 = 60.5\ cm$

C When the galvanometer and cell are interchanged at the balance point of the bridge, the meter will show no deflection.

Q

11 Emf $= 8.0\,V$

$r = 0.5\,\Omega$

$V = 120\,V$

$R = 15.5\,\Omega$

$V' = ?$

$V' = V - E$

$= 120 - 8 = 112\,V$

$I = \frac{V'}{R+r} = \frac{112}{16} = 7\,A$

$IR = 7 \times 15.5 = 108.5\,V$

Terminal voltage $= 120 - 108.5 = 11.5\,V$

12 Emf $= 1.25\,V$

$l = 35.0\,cm$

$l_1 = 63.0\,cm$

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

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

$= 1.25 \times \frac{63}{35} = 2.25\,V$

14 $\sigma = 10^{-9}\,Cm^{-2}$

$I = 1800\,A$

$r = 6.37 \times 10^{6}\,m$

$A = 4\pi r^2$

$= 4\pi \times (6.37 \times 10^{6})^2$

$= 5.07 \times 10^{14}\,m^2$

$q = \sigma \times A$

$= 10^{-9} \times 5.09 \times 10^{14}$

$= 5.09 \times 10^{5}\,C$

$$I = \frac{q}{t}$$

$$I = \frac{5.09 \times 10^{5}}{1800} = 282.77\,S$$

15 a $n = 6$

$E = 2.0\,V$

$r = 0.015\,\Omega$

$R = 8.5\,\Omega$

$$I = \frac{nE}{R + nR'} = \frac{6 \times 2}{8.5 + 6 \times 0.015} = \frac{12}{8.59} = 1.39\,A$$

$V = IR = 1.39 \times 8.5 = 11.87\,A$

b $E = 1.9\,V$

$r = 380\,\Omega$

$$\frac{E}{r} = \frac{1.9}{380} = 0.005\,A$$

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16. $\rho_{Al} = 2.63 \times 10^{-8}$ Ωm
$d_1 = 2.7$
l_1, R_1, A_1

$\rho_{Cu} = 1.72 \times 10^{-8}$ Ωm
$l_2\ R_2\ A_2$

$R_1 = \rho_1 \frac{l_1}{A_1}$

$R_2 = \rho_2 \frac{l_2}{A_2}$

$R_1 = R_2$

$\rho_1 \frac{l_1}{A_1} = \rho_2 \frac{l_2}{A_2}$

2.63 x 10^-8 and $l_1 = l_2$

$\frac{\rho_1}{A_1} = \frac{\rho_2}{A_2}$

$\frac{2.63 \times 10^{-8}}{1.72 \times 10^{-8}} = \frac{2.63}{1.72}$

$m_1 = V \times d$
$= A_2 l_2 \times d_2 = A_2 l_2 d_2$

$\frac{M_1}{M_2} = \frac{A_1 l_1 d_1}{A_2 l_2 d_2} \Rightarrow \frac{M_1}{M_2} = \frac{A_1 d_1}{A_2 d_2} \cdot \frac{A_1}{A_2} = \frac{2.63}{1.72}$

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$$\frac{m_1}{m_2} = \frac{2.63}{1.72} \times \frac{2.7}{8.9} = 0.46$$

17 It can be inferred from the given table that the ratio of voltage with current is a constant which is equal to 19.7. Hence, manganin is an ohmic conductor. The alloy obey ohm's law, the ratio of voltage with current is the resistance of manganin is 9.7 Ω

18 a When a steady current flows in a metallic conductor of non-uniform cross section, electric field and drift speed are inversely ∝ to the area of cross section

b No, ohm's law is not universally for all conducting elements. Vaccum diode semi-conductor. Ohm's law is not valid for it.

c According to ohm's law the relation is V = IR

$$V \propto I$$

$$I = \frac{V}{R}$$

d In order to prohibit the current from exceeding the safety limit a high tension supply must have a very large internal resistance

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a Alloys of metals usually have greater resistivity than that of their constant metals.

b Alloys usually have lower temp coefficient of resistance than pure metals.

c The resistivity have ~~lower~~ alloy, manganin is nearly in independent of increase of temperature.

d The resistivity of a typical insulator is greater than that of a metal by a factor of the order of 10^{22}

20

a Total number of resistor = n
Resistance of each resistor = R

i $R_1 = nR$

ii $R_2 = \frac{R}{n}$

iii $\frac{R_1}{R_2} = \frac{nR}{\frac{R}{n}} = n^2$

b $R_1 = 1\Omega$ $R_2 = 2\Omega$ $R_3 = 3\Omega$
$R = \frac{11}{3}\Omega$

c

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21 $R = 1\Omega$

$R' = 2 + \frac{R'}{R+1}$

$(R)^2 - 2R - 2 = 0$

$R' = \frac{2 \pm \sqrt{4+8}}{2}$

$= \frac{2 \pm \sqrt{12}}{2} = 1 \pm \sqrt{3}$

$R' = (1+\sqrt{3}) = 1 + 1.73 = 2.73\Omega$

$r = 0.5\Omega$

$R_{total} = 2.73 + 0.5 = 3.23\Omega$

$V = 12V$

$I = \frac{12}{3.23} = 3.72A$

22 $E_1 = 1.02V$

$l_1 = 67.3$ cm

$l = 82.3$ cm

$\frac{E_1}{l_1} = \frac{\varepsilon}{l}$

$\varepsilon = \frac{l}{l_1} \times E_1$

$= \frac{82.3}{67.3} \times 1.02 = 1.247V$

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b The purpose of using the high resistance of 600kΩ is to reduce the current through the galvanometer when the movable contact is far from the point.

c Not affected by the presence of high resistance

d not affected by internal resistance of driver cell.

e ~~The method would not work well for determining an extremely small emf.~~

It won't work if the driver cell of the potentiometer had an emf of 1.0 V and instead of 2.0 V.

23 $R = 10\Omega$

$l_1 = 58.3\text{ cm}$

$I = ?$

$E_1 = iR$

$X = ?$

$l_2 = 68.3\text{ cm}$

$E_2 = iX$

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

$$\frac{iR}{ix} = \frac{l_1}{l_2}$$

$$X = \frac{l_1}{l_2} \times R$$

$$= \frac{68.5}{58.3} \times 10 = 11.749\Omega$$

$X_1 = 11.75\Omega$