Ch-3 - Current Electricity
NCERT EXERSISES

1) Emf of the battery, $E = 12V$
Internal resistance of the battery, $r = 0.4\Omega$
Max current drawn $= I$

So, according to ohm's law,
$E = Ir$
$I = \frac{E}{r}$
$= \frac{12}{0.4} = 30A$

So Ans = $\boxed{30A}$

2) Emf of the battery, $E = 10V$
Internal resistance of the battery, $r = 3\Omega$

Current in the circuit, $I = 0.5A$.
Resistance of the resistor $= R$

$I = \frac{E}{R+r}$
$R + r = \frac{E}{I}$
$= \frac{10}{0.5} = 20\Omega$

$\therefore R = 20 - 3 = 17\Omega$

Terminal voltage of resistor $= V$.

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

3) Total resistance $= 1+2+3 = 6\,\Omega$

Current flowing through $= I$

Emf of the battery, $E = 12\,V$

Total r of the circuit $= R = 6\,\Omega$

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

$$= \frac{12}{6} = 2\,A$$

P drop across $1\,\Omega$ r $= V_1$

→ from ohm's law,

$V_1 = 2 \times 1 = 2\,V$ --- (i)

→ $V_2 = 2 \times 2 = 4\,V$ --- (ii)

→ $V_3 = 2 \times 3 \times 6\,V$ --- (iii)

4) There are 3 resistors of resistances,

$R_1 = 2\,\Omega$

$R_2 = 4\,\Omega$

$R_3 = 5\,\Omega$

So Total Resistance

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\rightarrow \frac{1}{2} + \frac{1}{4} + \frac{1}{5} = \frac{10+5+4}{20} = \frac{19}{20}$$

$$\therefore R = \frac{20}{19}\,\Omega$$

$\therefore$ Emf of the battery $= V = 20\,V$

PTO →

- Current I flowing through R_1 :-

$$I_1 = \frac{V}{R_1}$$

$$\Rightarrow \frac{20}{2} = 10A$$

- current (I_2) flowing through Resistor R_2,

$$I_2 = \frac{V}{R_2}$$

$$\rightarrow \frac{20}{4} = 5A$$

- Current (I_3) flowing through Resistor R_3,

$$I_3 = \frac{V}{R_3}$$

$$\Rightarrow \frac{20}{5} = 4A$$

Total current, $I = I_1 + I_2 + I_3$

$$\rightarrow 10 + 5 + 4 = 19A.$$

5) Room temperature, $T = 27°C$

R of the heating element at T, $R = 100\ \Omega$

R of the heating element at T_1, $R_1 = 117\ \Omega$

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

α is given by the relation,

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

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

$\Rightarrow T_1 - 27 = \dfrac{117 - 100}{100(1.7\times10^{-4})}$

$\rightarrow T_1 - 27 = 1000$

$\rightarrow T_1 = 1027°C$

6) $l = 15m$

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

$R = 5.0 \Omega$

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

$\rho = \dfrac{RA}{l}$

$= \dfrac{5\times6\times10^{-7}}{15} = 2\times10^{-7} \Omega m$

7) Temperature, $T_1 = 27.5°C$

$R_1 = 2.1 \Omega$

$T_2 = 100°C$

$R_2 = 2.7 \Omega$

$\alpha = \dfrac{R_2 - R_1}{R_1(T_2 - T_1)}$

$\rightarrow \dfrac{2.7 - 2.1}{2.1(100 - 27.5)} = 0.0039 °C^{-1}$

8) $V = 230V$

$I_1 = 3.2 A$

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

$\Rightarrow I_2 = 2.8A$

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

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

$\Rightarrow T_1 = 27.0^\circ C$

$\Rightarrow \alpha = \frac{R_2 - R_1}{R_1 (T_2 - T_1)}$

$\Rightarrow$

$T_2 - 27^\circ C = \frac{82.14 - 71.87}{71.87 \times 1.7 \times 10^{-4}} = 840.5$

$\Rightarrow T_2 = 840.5 + 27 = 867.5^\circ C$

8 (a) Balance point from end A, $l_1 = 39.5$ cm.
Resistance of the resistor $Y = 12.5\,\Omega$

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

$\therefore$ Resistance of resistor X is $8.2\,\Omega$

$\Rightarrow$ if X and Y are interchanged, then l_1 and $100 - l_1$ get interchanged

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

11) $E = 8.0V$
$r = 0.5\,\Omega$
$V = 120V$
$R = 15.5\,\Omega$

$V' = V - E$

$V' = 120 - 8 = 112\ V$

·) Current flowing in the circuit = I, which is given by relation,

$$I = \frac{V'}{R + r}$$

$$\Rightarrow \frac{112}{15.5 + 5} = \frac{112}{16} = 7\ A$$

Voltage across each Resistor R, is given by $112 = 7 \times 15$ = 108.5V.

So $120 - 108.5 = 11.5\ V$.

(2) $E_1 = 1.25\ V$

$l_1 = 35\ cm$

$l_2 = 63\ cm$

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

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

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

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13) $n = 8.5 \times 10^{28} m^{-3}$
$l = 3.0 m$
$A = 2.0 \times 10^{-6} m^2$

$I = n A e v_d$

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

$= \frac{\text{length of the wire } (l)}{\text{time taken to cover } l (t)}$

V_d = Drift velocity

$I = n A e \frac{l}{t}$
$t = \frac{n A e l}{I}$

$= \frac{3 \times 8.5 \times 10^{28} \times 2 \times 10^{-6} \times 1.6 \times 10^{-19}}{3.0}$

$= 2.7 \times 10^{4} s$

14) $\sigma = 10^{-9} C m^{-2}$
$I = 1800 A$
$r = 6.37 \times 10^{6} m$

$A = 4 \pi r^2$
$= 4\pi \times (6.37 \times 10^{6})^2$
$= 5.09 \times 10^{14} m^2$

Charge on the earth surface,
$q = \sigma A$
$\Rightarrow 10^{-9} \times 5.09 \times 10^{14}$
$\Rightarrow 5.09 \times 10^{5} C$

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

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

$\Rightarrow \frac{5.09 \times 10^{3}}{1800} = 2.8277$

15) $n = 6$

$E = 2.0V$

$r = 0.015\,\Omega$

$R = 8.5\,\Omega$

$I = \frac{nE}{R + nr}$

$= \frac{6 \times 2}{8.5 + 6 \times 0.015}$

$\Rightarrow \frac{12}{8.59} = 1.39A$

After long use, emf of the secondary cell, E = 1.9
IR of the cell = r = 380 Ω

So maximum current $= \frac{E}{r} = \frac{1.9}{380} = 0.005A$.

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. Hence the resistance of manganin is 19.7 Ω

18) When a steady current flows in a metallic conductor of non-~~current~~ uniform cross section the current flowing through the conductor is

constant. Current density, electric field, and drift speed are inversely proportional to the area of cross-section. ∴ they are not constant.

⇒ No, Ohm's law is not universally applicable for all conducting elements. Vaccum diode semi-conductor is a non-ohmic conductor. Ohm's law is not valid for it.

⇒ According to Ohm's Law, the relation for the potential is $V = IR$, voltage (V) is directly proportional to current (I)

R is the internal resistance of the source.

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

Q-14) Alloys of metals usually have greater resistivity than that of their constituent metals.

⇒ Alloys usually have lower temperature coefficients of resistance than pure metals.

⇒ The resistivity of the alloy, manganin, is nearly independent of increase of temperature

Q-21 $R = 1\Omega$

Equivalent resistance of the given circuit = R

The network is infinite. Hence, equivalent resistance is given by relation,

$\therefore R = 2 + \frac{R}{(R+1)}$

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

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

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

⇒ Negative value of R cannot be accepted.

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

⇒ $r = 0.5\ \Omega$

⇒ $2.73 + 0.5 = 3.23\ \Omega$ (Total Resistance)

⇒ $V = 12\ V$

∴ So according to ohms law, the ratio, $\frac{12}{3.23} =$ 3.22 A.

(2) $E_1 = 1.02\ V$

$l_1 = 67.3$ cm

$l = 82.3$ cm

⇒ The relation connecting emf and balance point is ⇒

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

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

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

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

- The method would not work, if the driver cell of the potentiometer had an emf of 1.0V instead of 2.0V, as if the emf of the driver cell of the potentiometer is less than emf of the other cell, there would be no balance point.

- The circuit would not work well for determining an extremely small emf.

- The given circuit can be modified if a series resistor is connected with wire AB.

23) $R = 10.0\,\Omega$

$l_1 = 58.3\,cm$

$i = iR$

$= x$

$l_2 = 68.5\,cm$

- Potential drop across x, $E_2 = ix$

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

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

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

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

If we fail to find a balance point with a given cell of emf, E_1 then the potential drop across R and x must be reduced.

2c) Let the internal resistance of the cell be = r

$l_1 = 76.3$ cm

$R = 9.5\,\Omega$

$l_2 = 64.8$ cm

The relation connecting resistance and emf is

$$\Rightarrow r = \left(\frac{l_1 - l_2}{l_2}\right) R$$

$$\Rightarrow \frac{76.3 - 64.8}{64.8} \times 9.5 = 1.68\,\Omega$$

∴ The internal resistance of the cell is $1.68\,\Omega$