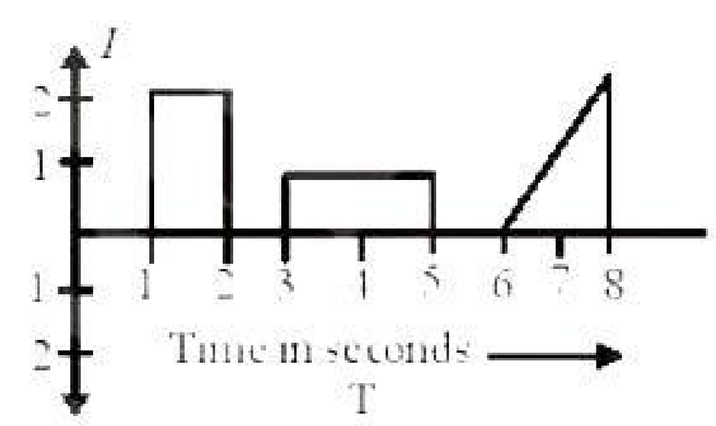
# CURRENT ELECTRICITY

# 17

1. The resistance of a wire at room temperature 30°C is found to be 10 Ω. Now to increase the resistance by 10%, the temperature of the wire must be [The temperature coefficient of resistance of the material of the wire is 0.002 per °C]
(a) 36°C (b) 83°C
(c) 63°C (d) 33°C

2. The plot represent the flow of current through a wire at three different time intervals. The ratio of charges flowing through the wire corresponding to these time intervals is (Fig.)
(a) 2 : 1 : 2
(b) 1 : 3 : 3
(c) 1 : 1 : 1
(d) 2 : 3 : 4



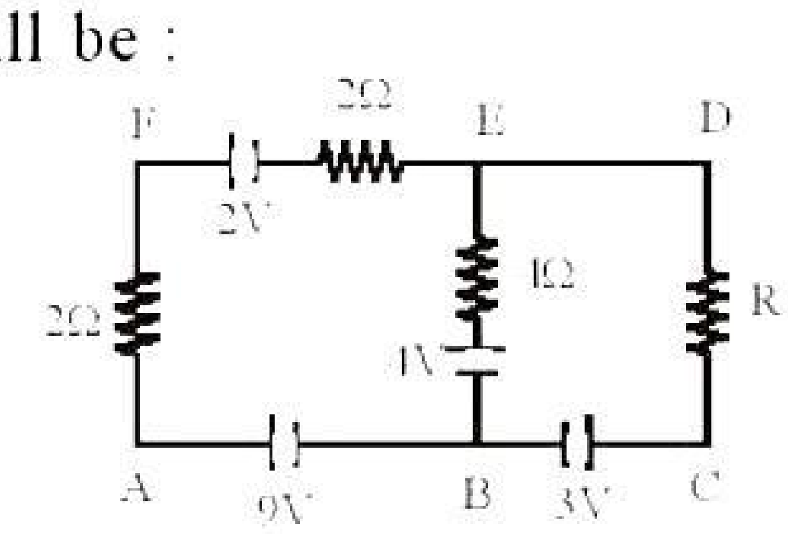

3. A current of 2A flows through a 2Ω resistor when connected across a battery. The same battery supplies a current of 0.5 A when connected across a 9Ω resistor. The internal resistance of the battery is
(a) 0.5 Ω (b) 1/3 Ω
(c) 1/4 Ω (d) 1 Ω

4. The n rows each containing m cells in series are joined in parallel. Maximum current is taken from this combination across an exernal resistance of 3Ω resistance. If the total number of cells are 24 and internal resistance of each cells is 0.5Ω, then
(a) m = 8, n = 3 (b) m = 6, n = 4
(c) m = 12, n = 2 (d) m = 2, n = 12

5. Five cells each of emf $E$ and internal resistance $r$ send the same amount of current through an external resistance $R$ whether the cells are connected in parallel or in series. Then the ratio $\left(\frac{R}{r}\right)$ is
(a) 2 (b) 1/2
(c) 1/5 (d) 1

6. A wire when connected to 220 V mains supply has power dissipation $P_1$. Now the wire is cut into two equal pieces which are connected in parallel to the same supply. Power dissipation in this case is $P_2$. Then $P_2 : P_1$ is
(a) 1 (b) 4
(c) 2 (d) 3

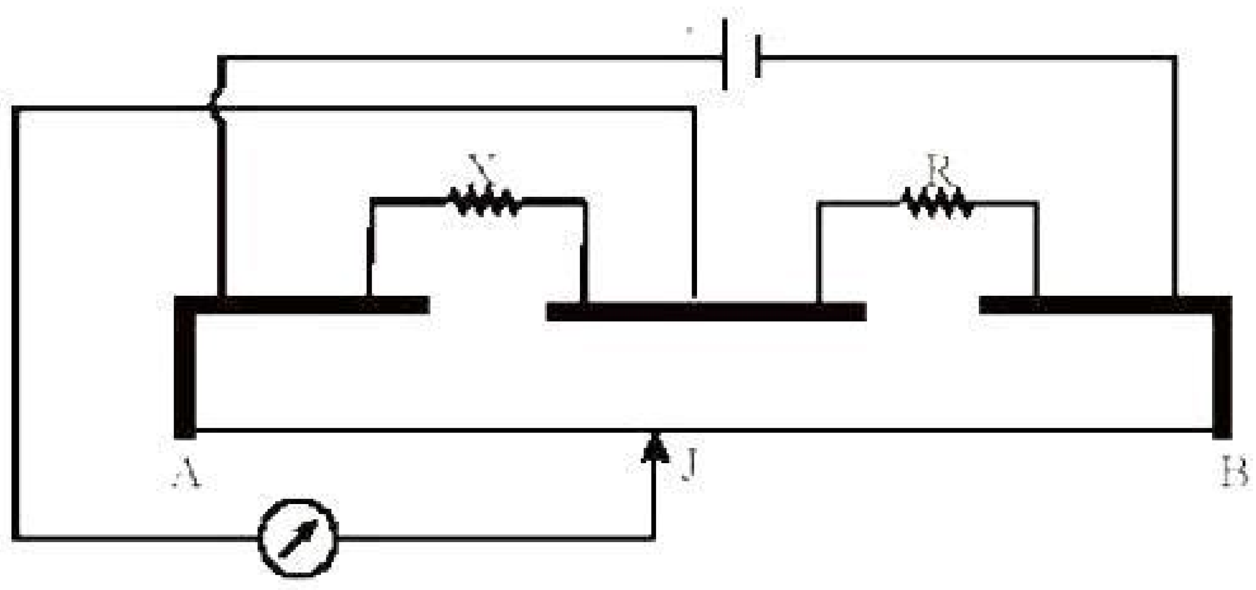
7. In the electric network shown, when no current flows through the 4Ω resistor in the arm EB, the potential difference between the points A and D will be :
(a) 6 V
(b) 3 V
(c) 5 V
(d) 4 V



8. In a meter bridge experiment null point is obtained at 20 cm. from one end of the wire when resistance $X$ is balanced against another resistance $Y$. If $X < Y$, then where will be the new position of the null point from the same end, if one decides to balance a resistance of $4X$ against $Y$

(a) 40 cm (b) 80 cm
(c) 50 cm (d) 70 cm

9. The figure shows a meter-bridge circuit, X = 12Ω and R = 18Ω. The jockey J is at the null point. If R is made 8Ω, through the jockey J have to be moved by 4 × A cm to obtain null point again then find the value of A.




(a) 2 (b) 5
(c) 8 (d) 6

10. When a wire of uniform cross–section a, length l and resistance R is bent into a complete circle, equivalent resistance between any two of diametrically opposite points will be

(a) $\frac{R}{4}$ (b) 4R
(c) $\frac{R}{8}$ (d) $\frac{R}{2}$

11. A student measures the terminal potential difference (V) of a cell (of emf E and internal resistance r) as a function of the current (I) flowing through it. The slope and intercept, of the graph between V and I, respectively, are

(a) –r and E (b) r and –E
(c) –E and r (d) E and –r

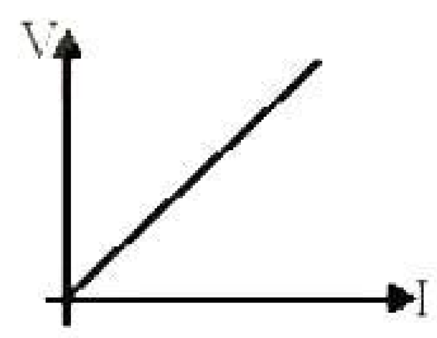
12. A heater boils a certain quantity of water in time $t_1$ Another heater boils the same quantity of water in time $t_2$. If both heaters are connected in parallel, the combination will boil the same quantity of water in time

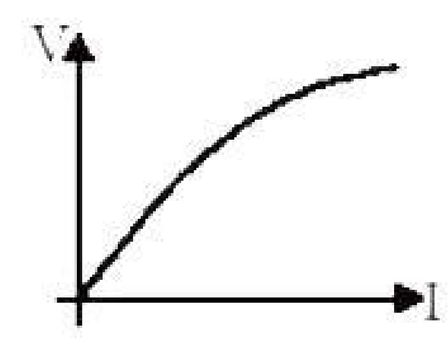
(a) $\frac{1}{2}(t_1 + t_2)$ (b) $(t_1 + t_2)$
(c) $\frac{t_1 t_2}{t_1 + t_2}$ (d) $\sqrt{t_1 t_2}$

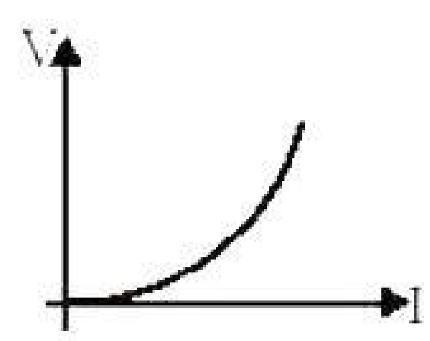
13. A battery of emf E produces currents $I_1$ and $I_2$ when connected to external resistances $R_1$ and $R_2$ respectively. The internal resistance of the battery is

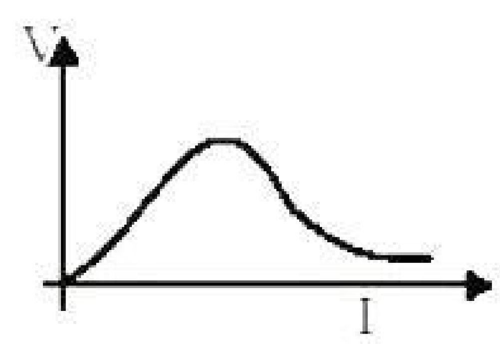
(a) $\frac{I_1R_2 - I_2R_1}{I_2 - I_1}$ (b) $\frac{I_1R_2 + I_2R_1}{I_1 - I_2}$
(c) $\frac{I_1R_1 + I_2R_2}{I_1 - I_2}$ (d) $\frac{I_1R_1 - I_2R_2}{I_2 - I_1}$

14. Suppose the drift velocity $v_d$ in a material varied with the applied electric field E as $v_d \propto \sqrt{E}$. Then V – I graph for a wire made of such a material is best given by :

(a) 

(b) 

(c) 

(d) 


15. The potential difference across the terminals of a battery is 50 V when 11A current is drawn and 60 V when 1A current is drawn. The e.m.f. and the internal resistance of the battery are

(a) 62V, 2Ω (b) 63V, 1Ω
(c) 61V, 1Ω (d) 64V, 2Ω

16. In a large building, there are 15 bulbs of 40 W, 5 bulbs of 100 W, 5 fans of 80 W and 1 heater of 1 kW. The voltage of electric mains is 220 V. The minimum capacity of the main fuse of the building will be:

(a) 8A (b) 10A
(c) 12A (d) 14A

17. Two sources of equal emf are connected to an external resistance $R$. The internal resistance of the two sources are $R_1$ and $R_2$ $(R_1 > R_1)$. If the potential difference across the source having internal resistance $R_2$ is zero, then

(a) $R = R_2 - R_1$

(b) $R = R_2 \times (R_1 + R_2)/(R_2 - R_1)$

(c) $R = R_1 R_2/(R_2 - R_1)$

(d) $R = R_1 R_2/(R_1 - R_2)$

**18.** A current of 5 A passes through a copper conductor (resistivity) = $1.7 \times 10^{-8}\Omega$m) of radius of cross-section 5 mm. Find the mobility of the charges if their drift velocity is $1.1 \times 10^{-3}$ m/s.

(a) 1.8m²/Vs (b) 1.5m²/Vs

(c) 1.3m²/Vs (d) 1.0m²/Vs

**19.** An electric current passes through a circuit containing two wires of the same material connected in parallel. If the lengths of the wires are in the ratio of 4/3 and radius of the wires are in the ratio of 2/3, then the ratio of the currents passing through the wires will be

(a) 3 (b) 1/3

(c) 3/9 (d) 4/9

**20.** Two identical cells connected in series send 1.0A current through a 5 Ω resistor. When they are connected in parallel, they send 0.8 A current through the same resistor. What is the internal resistance of the cell?

(a) 0.5 Ω (b) 1.0 Ω

(c) 1.5 Ω (d) 2.5 Ω

**21.** A battery is charged at a potential of 15V for 8 hours when the current flowing is 10A. The battery on discharge supplies a current of 5A for 15 hours. The mean terminal voltage during discharge is 14V. The "watt-hour" efficiency of the battery is

(a) 87.5% (b) 82.5%

(c) 80% (d) 90%

**22.** In an experiment to measure the internal reistance of a cell by a potential, it is found that the balance point is at a length of 2 m when the cell is shunted by a 5 Ω resistance and is at a length of 3 m when the cell is shunted by a 10 Ω resistance, the internal resistance of the cell is then

(a) 1.5 Ω (b) 10 Ω

(c) 15 Ω (d) 1 Ω

**23.** When 5V potential difference is applied across a wire of length 0.1 m, the drift speed of electrons is $2.5 \times 10^{-4}$ ms$^{-1}$. If the electron density in the wire is $8 \times 10^{28}$ m$^{-3}$, the resistivity of the material is close to :

(a) $1.6 \times 10^{-6}\,\Omega$m (b) $1.6 \times 10^{-5}\,\Omega$m

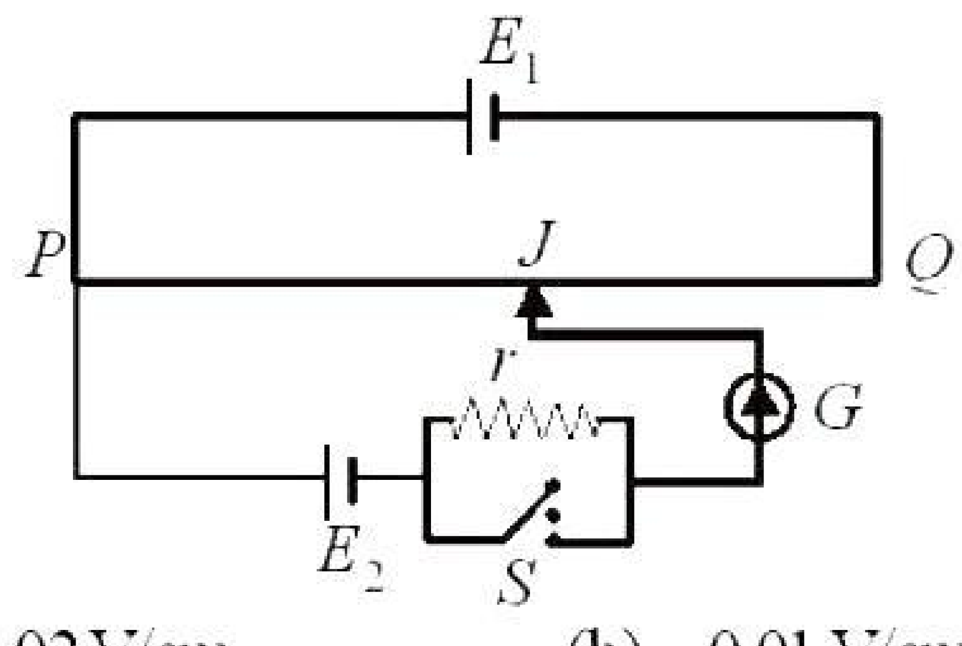
(c) $1.6 \times 10^{-8}\,\Omega$m (d) $1.6 \times 10^{-7}\,\Omega$m

**24.** Four resistances of 15 Ω, 12 Ω, 4 Ω and 10 Ω respectively in cyclic order to form Wheatstone's network. The resistance that is to be connected in parallel with the resistance of 10 Ω to balance the network is

(a) 10 Ω (b) 15 Ω

(c) 20 Ω (d) 25 Ω

**25.** A potentiometer wire *PQ* of 1 m length is connected to a standard cell $E_1$. Another cell $E_2$ of emf 1.02 V is connected with a resistance '*r*' and switch *S* (as shown in figure). With switch *S* open, the null position is obtained at a distance of 49 cm from *Q*. The potential gradient in the potentiometer wire is :




(a) 0.02 V/cm (b) 0.01 V/cm

(c) 0.03 V/cm (d) 0.04 V/cm

**ANSWER KEY**

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | (b) | 4 | (c) | 7 | (c) | 10 | (a) | 13 | (d) | 16 | (c) | 19 | (b) | 22 | (b) | 25 | (a) |
| 2 | (c) | 5 | (d) | 8 | (c) | 11 | (a) | 14 | (c) | 17 | (a) | 20 | (d) | 23 | (b) | | |
| 3 | (b) | 6 | (b) | 9 | (b) | 12 | (c) | 15 | (c) | 18 | (d) | 21 | (a) | 24 | (a) | | |

# 17 Current Electricity

1. **(b)** $R_t = R_0(1+\alpha t)$
Initially, $R_0(1+30\alpha) = 10\,\Omega$
Finally, $R_0(1+\alpha t) = 11\,\Omega$
$$\therefore \frac{11}{10} = \frac{1+\alpha t}{1+30\alpha}$$
or, $10 + (10 \times 0.002 \times t) = 11 + 330 \times 0.002$
or, $0.02t = 1 + 0.66$ or $t = \dfrac{1.66}{0.02} \approx 83°C$.

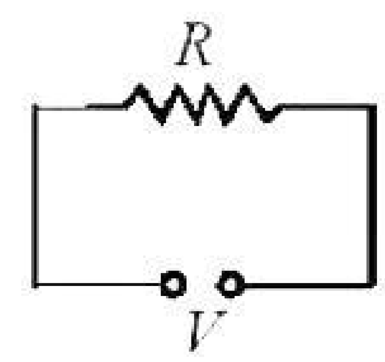
2. **(c)** Charge = area under the current – time graph
$q_1 = 2 \times 1 = 2,\ q_2 = 1 \times 2 = 2,$
and $q_3 = \dfrac{1}{2} \times 2 \times 2 = 2$
$q_1 : q_2 : q_3 = 2 : 2 : 2 = 1 : 1 : 1$

3. **(b)** Let the internal resistance of the battery be r. Then the current flowing through the circuit is given by
$$i = \frac{E}{R+r}$$
In first case, $2 = \dfrac{E}{2+r}$ ...(1)
In second case, $0.5 = \dfrac{E}{9+r}$ ...(2)
From (1) & (2),
$4 + 2r = 4.5 + 0.5r \Rightarrow 1.5r = 0.5 \Rightarrow r = \dfrac{1}{3}\,\Omega.$

4. **(c)**

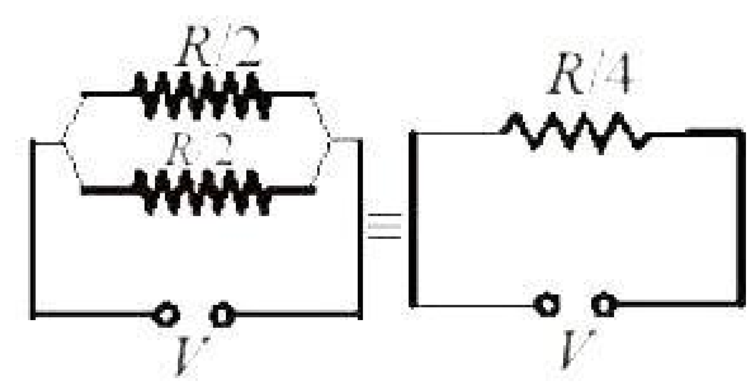
5. **(d)** Given : Number of cells, $n = 5$, emf of each cell $= E$
Internal resistance of each cell $= r$
In series, current through resistance $R$
$$I = \frac{nE}{nr+R} = \frac{5E}{5r+R}$$
In parallel, current through resistance $R$
$$I' = \frac{E}{\frac{r}{n}+R} = \frac{nE}{r+nR} = \frac{5E}{r+5R}$$
According to question, $I = I'$
$$\therefore \frac{5E}{5r+R} = \frac{5E}{r+5R} \Rightarrow 5r + R = r + 5R$$
or $R = r \quad \therefore \dfrac{R}{r} = 1$

6. **(b)** Case 1 $P_1 = \dfrac{V^2}{R}$




Case 2
The wire is cut into two equal pieces. Therefore, the resistance of the individual wire is $\dfrac{R}{2}$. These are connected in parallel

$$\therefore R_{eq} = \frac{R/2}{2} = \frac{R}{4}$$



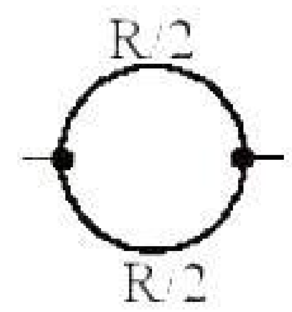

$$\therefore P_2 = \frac{V^2}{R/4} = 4\left(\frac{V^2}{R}\right) = 4P_1$$

7. **(c)**

8. **(c)** $\dfrac{R_1}{R_2} = \dfrac{\ell_1}{\ell_2}$ where $\ell_2 = 100 - \ell_1$
In the first case $\dfrac{X}{Y} = \dfrac{20}{80}$
In the second case $\dfrac{4X}{Y} = \dfrac{\ell}{100-\ell} \Rightarrow \ell = 50$ cm

9. **(b)** If $\ell_1$ = length from one end then
$$\frac{\ell_1}{1-\ell_1} = \frac{X}{R} = \frac{12}{18}$$
$\ell_1 = \dfrac{12}{30}$m = 40cm
and $\ell'_1$ = length from one end in second case
$$\frac{\ell'_1}{1-\ell'_1} = \frac{X}{R'} = \frac{12}{8} = 60 \text{ cm.; shift} = 20 \text{ cm}$$

10. **(a)** $R_{eq} = \frac{R_1R_2}{R_1+R_2} = \frac{\left(\frac{R}{2}.\frac{R}{2}\right)}{\frac{R}{2}+\frac{R}{2}} = \frac{R}{4}$




11. **(a)** The terminal potential difference of a cell is given by $V + Ir = E$

$V = V_A - V_B$ or $V = E - Ir \Rightarrow \frac{dV}{dI} = -r,$

Also for, $i = 0$ then $V = E$ slope $= -r$,

intercept $= E$

12. **(c)** If a heater boils m kg water in time $t_1$ and another heater boils the same water in $t_2$, then both connected in series will boil the same water in time $t_s = t_1 + t_2$ and if in parallel $t_p = \frac{t_1t_2}{t_1+t_2}$

[Use time taken $\propto$ Resistance]

13. **(d)**

14. **(c)** $i = neAV_d$ and $V_d \propto \sqrt{E}$ (Given)

or, $i \propto \sqrt{E}$

$i^2 \propto E$

$i^2 \propto V$

Hence graph (c) correctly dipicts the *V-I* graph for a wire made of such type of material.

15. **(c)**

16. **(c)** Total power consumed by electrical appliances in the building, $P_{total} = 2500W$

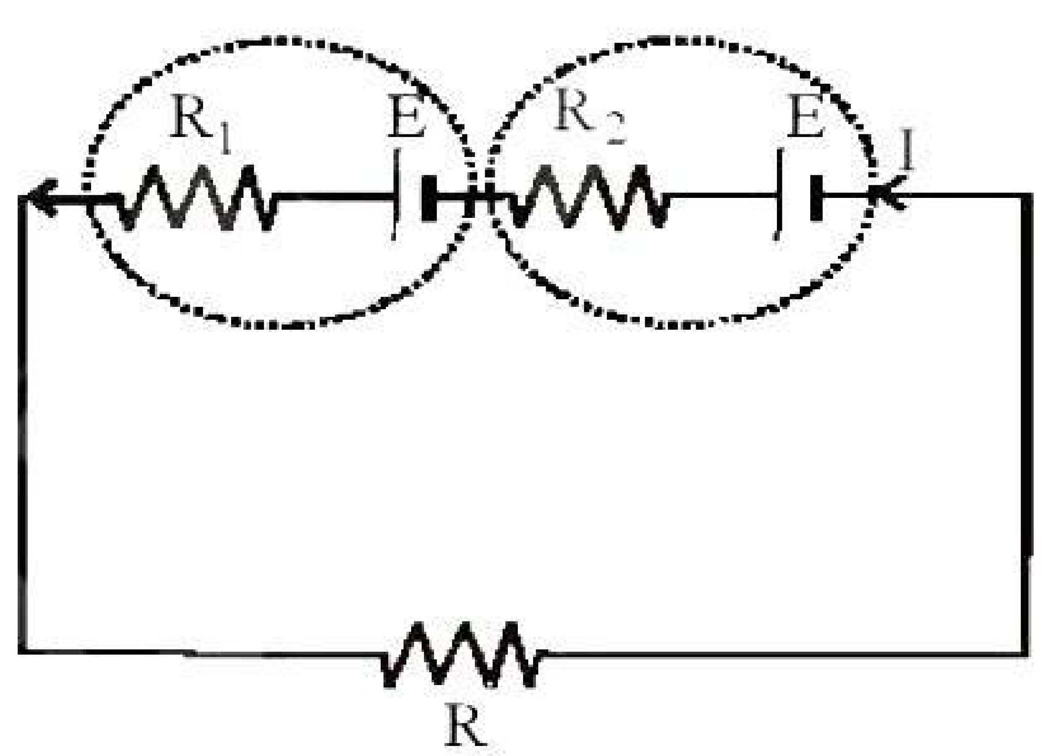
Watt = Volt × ampere

$\Rightarrow 2500 = V \times I \Rightarrow 2500 = 220\,I$

$\Rightarrow I = \frac{2500}{220} = 11.36 \approx 12A$

(Minimum capacity of main fuse)

17. **(a)**




Let $E$ be the emf of each source of current

Current in the circuit $I = \frac{2E}{R+R_1+R_2}$

Potential difference across cell having internal resistance $R_2$

$V = E - iR_2 = 0$

$E - \frac{2E}{R+R_1+R_2}\cdot R_2 = 0$

$\Rightarrow R + R_1 + R_2 - 2R_2 = 0$

$\Rightarrow R + R_1 - R_2 = 0$

$\Rightarrow R = R_2 - R_1$

18. **(d)** Charge mobility

$(\mu) = \frac{V_d}{E}$ [Where $V_d$ = drift velocity]

and resistivity $(\rho) = \frac{E}{j} = \frac{EA}{I} \Rightarrow E = \frac{I(\rho)}{A}$

$\Rightarrow \mu = \frac{V_d}{E} = \frac{V_dA}{I_\rho}$

$= \frac{1.1\times10^{-3}\times\pi\times\left(5\times10^{-3}\right)^2}{5\times1.7\times10^{-8}}$

$\mu = 1.0\frac{m^2}{V_s}$

19. **(b)** Given: $\frac{\ell_1}{\ell_2} = \frac{4}{3}$ $\quad\frac{r_1}{r_2} = \frac{2}{3}$

Since the two wires are connected in parallel, potential remains same. i.e.,

V = constant.

IR = Constant

i.e., $I_1R_1 = I_2R_2 \Rightarrow \frac{I_1}{I_2} = \frac{R_2}{R_1}$ ..... (a)

But we know that, $R = \frac{\rho\ell}{A}$

$\therefore \frac{R_1}{R_2} = \left(\frac{\ell_1}{A_1}\right)\left(\frac{A_2}{\ell_2}\right)$ (since area, $A = \pi r^2$) = 3

Substitute this value in equation (a) we get,

$\frac{I_1}{I_2} = \frac{1}{3}.$

20. **(d)** Case (I) : $E + E = (r + r + 5)\,1$

or $2E = 2r + 5$ ...(i)

Case (II) : $E = \left(\frac{r\times r}{r+r}+5\right)\times0.8$

or $E = \left(\frac{r}{2}+5\right)0.8$

or $E = 0.4r + 4.0$ ...(ii)

Multiplying (ii) by 2 and equating with (i), we get

$2r + 5 = 0.8r + 8$ or $1.2r = 3$ or $r = \dfrac{3}{1.2} = 2.5$

**21.** **(a)** $\eta = \dfrac{5 \times 15 \times 14}{10 \times 8 \times 15} = 0.875$ or $87.5\,\%$

**22.** **(b)** In case of internal resistance measurement by potentiometer,

$$\frac{V_1}{V_2} = \frac{\ell_1}{\ell_2} = \frac{[ER_1/(R_1+r)]}{[ER_2/(R_2+r)]} = \frac{R_1(R_2+r)}{R_2(R_1+r)}$$

$$\Rightarrow \quad \frac{2}{3} = \frac{5}{10}\left[\frac{10+r}{5+r}\right] \Rightarrow r = 10\ \Omega$$

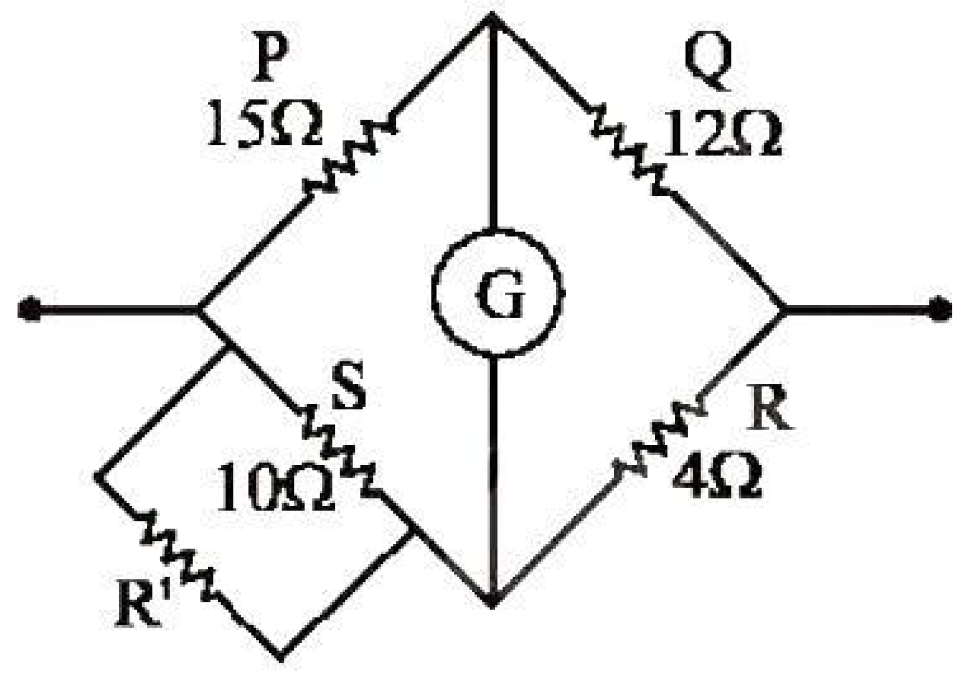
**23.** **(b)** $V = IR = (neAv_d)\rho\dfrac{\ell}{A}$

$\therefore \quad \rho = \dfrac{V}{V_d l n e}$

Here V = potential difference
l = length of wire
n = no. of electrons per unit volume of conductor.
e = no. of electrons
Placing the value of above parameters we get resistivity

$$r = \frac{5}{8 \times 10^{28} \times 1.6 \times 10^{-19} \times 2.5 \times 10^{-4} \times 0.1}$$
$= 1.6 \times 10^{-5}\,\Omega m$

**24.** **(a)**




As per Wheatstone bridge balance condition

$$\frac{P}{Q} = \frac{S}{R}$$

Let resistance R' is connected in parallel with resistance S of 10Ω

$$\therefore \frac{15}{12} = \frac{\frac{10R'}{10+R'}}{4} \Rightarrow 5 = \frac{10R'}{10+R'}$$

$\Rightarrow 50 + 5R' = 10R'$

$$\therefore R' = \frac{50}{5} = 10\Omega$$

**25.** **(a)** Potential gradient, $x = \dfrac{\text{Potential drop}}{\text{length}}$

Here, Potential drop = 1.02
Balancing length from P = 100 − 49

$$\therefore x = \frac{1.02}{100-49} = 0.02 \text{ volt/cm}$$