# CURRENT ELECTRICITY

## 2. CELLS

**POINTS TO REMBER**

**1. Electromotive force :**

a) The work done in moving a unit positive charge completely round the closed circuit including the battery is called emf.
b) emf is not a force. It is a scalar quantity.

**2. Potential difference :**

a) The work done in moving a unit positive charge between any two points in a circuit is called potential difference
b) Potential difference is a scalar quantity. It is the energy (or) work.

**3. Internal resistance (r) :**

a) The resistance offered by electrolyte and the electrodes of the cell to the flow of ions is called internal resistance of the cell (r).
b) The unit of internal resistance is ohm.
c) The internal resistance depends on the

I. Surface area of the electrodes $\left(r\alpha\frac{1}{A}\right)$.

II. The separation between the electrodes $(r\alpha d)$.

III. Nature and concentration of the electrolyte $(r\alpha c)$

IV. Temperature of the electrolyte $\left(r\alpha\frac{1}{t}\right)$

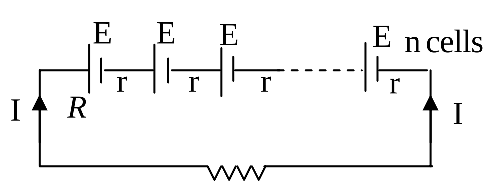
d) The internal resistance of an ideal cell is zero

**4. Terminal voltage and loss voltage**

a) $V=E-ir$ Where V is called the terminal voltage (or) terminal potential difference and $V^1=ir$ is called loss volts (or) internal voltage of the cell.
b) When the cell is in the charging condition, emf is less than the terminal voltage $V=E+Ir$.
c) When the cell is in the discharging condition emf is more than potential difference

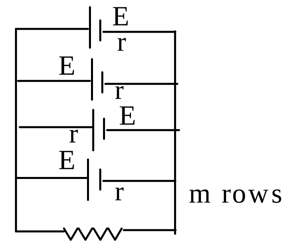
$$V=E-ir$$

**5. Grouping of cells : Cells in series :**




Current through the circuit = $I=\frac{nE}{R+nr}$

**6. Cells in parallel :**

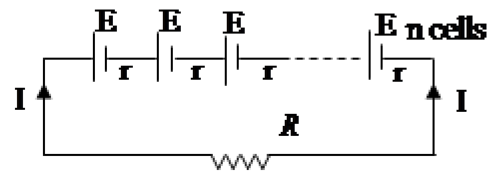



Current through the circuit (I) = $\frac{mE}{(r+mR)}$

## LONG ANSWER QUESTIONS

**1. Derive expressions for currents through a load resistance in series and parallel combinations of cells.**

A. **<u>Grouping of cells :</u>** **<u>Cells in series :</u>**




Consider n cells each of emf E internal resistance r connected in series through a load resistance R. Let I be the current through the net work.

Net emf in the circuit = nE

Net resistance in the circuit = $nr + R$

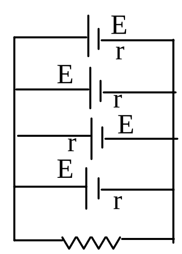
Current through the circuit = $I = \frac{nE}{R + nr}$

This combination is useful when

1. $r << R$ and 2. when large emf is required. (internal resistance is negligible compared to external resistance.

**<u>Cells in parallel :</u>**

Consider m identical cells each of emf E and internal resistance r connected in parallel to a load resistance R as shown in the figure. Let I be the current through the load resistance.




m rows

Net emf in the circuit = E

Net resistance in the circuit = $\frac{r}{m} + R = \frac{r + mR}{m}$

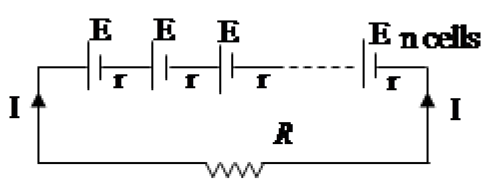
Current through the circuit (I) = $\frac{mE}{(r + mR)}$

This condition is useful when

a) Internal resistance is very large when compared to the external resistance.
b) Large current is required.

**2. Derive expression for the equivalent emf of (a) series combination and (b) parallel combination of electric cells.**

A. **<u>The expression for the equivalent e.m.f of series combination of cells:</u>**




The above circuit consists of series combination of n identical cells each of e.m.f E and internal resistance r. This combination is connected across an external resistance R

The current 'I' will have single path.

Apply K.V.L to the circuit

- iR – ir + E – ir + E (upto n terms of ir and n terms of E) = 0 i.e. $i\left(R+nr\right)=nE$

$$i=\left(\frac{nE}{R+nr}\right) \ldots\ldots.. (1)$$

If $\sum_{es}$ is equivalent e.m.f . of series combination, and $r_{es}$ is equivalent internal resistance of series combination,

$$i=\left(\frac{\varepsilon_{es}}{R+r_{es}}\right) \ldots\ldots(2)$$

From (1) and (2), we have

$\varepsilon_{es}=n\left(\varepsilon\right)$ and also, $r_{es}=nr$

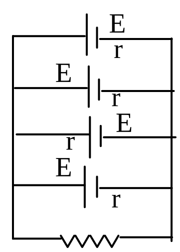
**Equivalent e.m.f for parallel combination of cells.**

Consider the parallel combination of n identical cells each of e.m.f E and internal resistance r as shown above

The current at Q branches out into n parts. All the cells are identical, the current through each will be $\left(\frac{i}{n}\right)$. We consider the total current at P to be i

Apply K.V.L to the circuit,

For first cell, $,-iR-\left(\frac{i}{n}\right)r+E=0$




For second cell, $-iR-\left(\frac{i}{n}\right)r+E=0$

For nth cell, $-iR-\left(\frac{i}{n}\right)r+E=0$

Adding these n equations, we get

$$-n\left(iR\right)-n\left(\frac{i}{n}\right)r+nE=0$$

$$i\left(nR+r\right)=nE\ (or)$$

$$i=\frac{\left(nE\right)}{nR+r}, i=\left(\frac{E}{R+\frac{r}{n}}\right)$$

If $\in_{ep}$ is equivalent e.m.f of the parallel combination, and $r_{ep}$ is equivalent internal resistance, we have

$$E_{ep}=E and\ r_{ep}=\left(\frac{r}{n}\right)$$

**SHORT ANSWER QUESTIONS**

**1. Write short notes on back e.m.f and internal resistance of a cell.**

A. **Back emf :** Due to the flow of current, the electrolyte decomposes into ions. This is called polarization. These ions travel in opposite direction of emf called back emf.

A voltaic cell consists of Zinc plate and copper plate dipped in dilute sulphuric acid. When the cell is in use as a result of chemical reaction $H_2$ gas is liberated at cathode and form a layer. Hence the effective area of the cathode in contact with the acid decreases. As a result the internal resistance of the cell increases. This action is called polarization. The strength of the current decreases. Therefore there exists an opposing emf called back emf is developed.

In electrolytic cells polarization can be eliminated by using oxidizing agent. The oxidizing agent is called are polarizer. In Leclanch cell $MnO_2$ is used as oxidizing agent.

**2. Write the expressions for electrical energy and electrical power. Define kilowatt hour unit of energy and show that 1 km h is equal to $36\times10^5 J$ .**

A. **Electrical energy :** If a current 'I' passes through a conductor for a time when its two ends maintained a potential difference $'v'$ then the electrical energy

$$W = V\,it = i^2Rt = \frac{V^2}{R}t$$

**Electrical power :** The rate at which electrical work is done is called the electrical power.

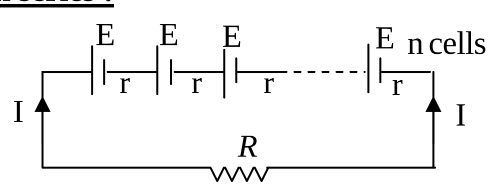
$$P = \frac{V}{t} = \frac{Vit}{t} \Rightarrow P = Vi = i^2R = \frac{V^2}{R}$$

**Kilowatt hour :** It is defined as the electrical energy consumed at the rate of one kilowatt per one hour

$$1KWh = = (1000W)(3600\sec) = 36\times10^5 J .$$

**3. Explain series combination of cells.**

A. **Cells in series :**




Consider n cells each of emf E internal resistance r connected in series through a load resistance R. Let I be the current through the net work.
Net emf in the circuit = nE
Net resistance in the circuit = $nr + R$
Current through the circuit = $I = \frac{nE}{R+nr}$
This combination is useful when
1. $r << R$ and 2. When large emf is required. (Internal resistance is negligible compared to external resistance.

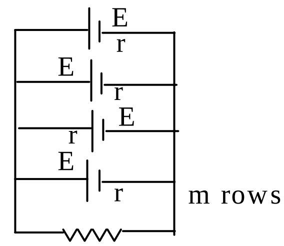
**4. Explain parallel combination of cells.**

A. m identical cells each of emf E and internal resistance r connected in parallel to a load resistance R as shown in the figure. Let I be the current through the load resistance.

Net emf in the circuit = E

Net resistance in the circuit = $\frac{r}{m}+R=\frac{r+mR}{m}$

Current through the circuit (I) = $\frac{mE}{(r+mR)}$



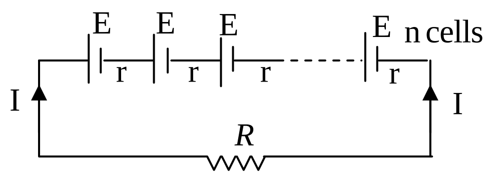

This condition is useful when

a) Internal resistance is very large when compared to the external resistance.

b) Large current is required.

**5. Derive an expression for the equivalent emf in the case of series combination of cells.**

A. **<u>Cells in series :</u>**

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Current through the circuit = $I=\frac{nE}{R+nr}$

This combination is useful when

1. $r<<R$ and 2. When large emf is required. (Internal resistance is negligible compared to external resistance.

**6. Derive an expression for the equivalent emf in the case of parallel combination of cells.**

A. Equivalent e.m.f for parallel combination of cells.

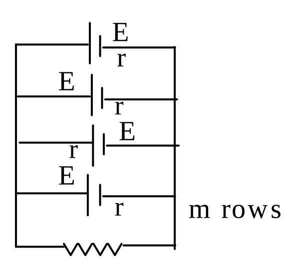
Consider the parallel combination of n identical cells each of e.m.f $\varepsilon$ and internal resistance r as shown above.

The current at Q branches out into n parts. All the cells are identical, the current through each will be $\left(\frac{i}{n}\right)$. We consider the total current at P to be i.

Apply K.V.L. to ckt

For first cell, $-iR-\left(\frac{i}{n}\right)r+E=0$

For second cell, $-iR-\left(\frac{i}{n}\right)r+E=0$



For nth cell, $-iR-\left(\frac{i}{n}\right)r+E=0$

Adding these n equation, we get

$$-n(iR)-n\left(\frac{i}{n}\right)r+nE=0$$

$$i(nR+r)=nE \qquad (or) \qquad i=\left(\frac{nE}{nR+r}\right), i=\left(\frac{E}{R+\frac{r}{n}}\right)$$

If $E_{ep}$ is equivalent e.m.f of the parallel combination, and $r_{ep}$ is equivalent internal resistance, we have

$$E_{ep}=E \text{ and } r_{ep}=\left(\frac{r}{n}\right)$$

## VERY SHORT ANSWER QUESTIONS

**1. Write three differences between e.m.f and p.d. (March2010)**

A.

| e.m.f | p.d |
|---|---|
| 1. the difference of potential between the terminals of a cell in an open circuit is e.m.f | 1. The difference of potential between the terminals of a cell in a closed circuit is P.D. |
| 2. The e.m.f of a cell is greater than P.D. | 2. The P.D. between any two points in a closed circuit. |
| 3. The emf does not depend upon external resistance. | 3. P.D. depends on external resistance. |

**2. What is an ideal cell? (May2009)**

A. A cell whose internal resistance is zero is called an ideal cell. It cannot be realized in practice.

**3. What is the terminal voltage of a cell? When it will be equal to the emf of the cell?**

A. the potential difference across the terminals of the cell, when no current flows through a cell in a circuit, is called as terminal voltage. In an open circuit, terminal voltage of a cell is equal to the emf of the cell.

**4. When a cell is charged by sending current into the cell, what will be the terminal potential difference of the cell.**

A. When a cell is charging, its terminal potential difference is greater than its emf by a factor 'ir' whichis called lost volts.

$\therefore V = E + ir$ where r is internal resistance of the cell.

**5. Define kilowatt hour unit of energy.**

A. Kilowatt –hour (KWh) : It is defined as the electrical energy consumed at the rate of one kilowatt for one hour.

$1KWh = 36 \times 10^5 \, Joule$

**6. Give expressions for electrical energy and electrical power**

A. Electrical energy $W = Vit = l^2Rt = \dfrac{V^2t}{R}$

Where I is current, V is potential difference, R is resistance and t is time.

Electrical power is the rate at which electrical work is done

$$P = \frac{W}{t} = Vi = i^2R = \frac{V^2}{R}$$

Where V is potential difference, I is current, R is resistance and t is time

**7. Show that 1 kWh is equal to** $36 \times 10^5 J$

A. 1 kilowatt hour = (1000W) (3600s) $= 36 \times 10^5 Ws = 36 \times 10^5 J$

**27. When is the series combination of cells advantageous and why ?**

A. This combination is useful when
1. $r << R$ and 2. when large emf is required. (internal resistance is negligible compared to external resistance.

**8. When is the parallel combination of cells advantageous and why? (June2010)**

A. This condition is useful when
a. Internal resistance is very large when compared to the external resistance.
b. Large current is required.

**<u>SOLVED PROBLEMS</u>**

**1. A battery when connected by a resistance of $16\Omega$ gives a terminal voltage of 12V and when connected by a resistance of $10\Omega$ gives a terminal voltage of 11V. Calculate the emf of the battery and its internal resistance.**

**Sol. V = E – Ir**

$$12 = E - \left(\frac{E}{16+r}\right)r \quad \text{and} \quad 11 = E - \left(\frac{E}{10+r}\right)r$$

Solving we get, $r = 2.857\Omega$ and E = 14.14 V

**2. A cell of emf 2V and internal resistance $0.5\Omega$ is connected across a resistance of $2.5\Omega$. Calculate the p.d. and current. Also calculate maximum current that can be obtained with the cell.**

**Sol.** $E = 2V$, and $r = 0.5\Omega$ ; $R = 2.5\Omega$

a) $i = \frac{E}{(R+r)} = \frac{2}{(2.5+0.5)} = 0.6666A$

Terminal voltage or p.d.

$V = E - ir = 2 - (0.5) \times \frac{2}{3} = 1.666V$

b) $i = \frac{E}{R+r}$ will be maximum when R = 0

Maximum current $i_m = \frac{E}{r} = \frac{2}{0.5} = 4A$

This occurs when the cell is short circuited. The cell gets damaged.

**3. There are 5 tube lights each of 40W in a house. These are used on an average for 5 hours per day. In addition, there is an immersion heater of 1500W used on an average for 1 hour per day. How many units of electricity are consumed in a month?**

**Sol.** Energy consumed by tube lights in a day

= No.of tube lights × wattage × hours of used per day

= 5× 40× 5 = 1000 watt – hours = 1 kWh.

Energy consumed by the heater in a day = 1×1500×1=1500 Wh = 1.5 kWh.

Total energy consumed in a day = 1kWh +1.5kWh = 2.5 kWh.

Total energy consumption in kWh per month = 2.5×30 = 75 kWh = 75 units.

**4. A house is fitted with ten lamps of each 60W. Each lamp burns for 5 hours a day on an average. Find the cost of consumption in a month of 30 days at 2 rupees 80 paise per unit.**

**Sol.** Electric energy consumed by 10 bulbs at the rate of 5 hours per day for 30 days = Total Wattage × hours of use × 30

$= (10 \times 60) \times 5 \times 30 \text{watt hours} = \frac{10 \times 60 \times 5 \times 30}{1000} \text{kWh} = 90\text{kWh}$ or 90 units

Cost of 1 unit = 2 rupees 80 paise

$\therefore$ Cost of 90 units = 90×2.80 = Rs 252.00

**UNSOLVED PROBLEMS**

1. When a battery is connected to a resistance of $10\Omega$ the current in the circuit is 0.12 A. the same battery gives 0.07 A current with $20\Omega$. Calculate e.m.f and internal resistance of the battery

A. If $R = 10\Omega, I = 0.12A$ v = I R

E = v + Ir $\Rightarrow E = 10(0.12) + 0.12r$

Or $(E) = 1.2 + 0.12r$ (or) E – 0.12r = 1.2… (1)

Again $R = 20\Omega, I = 0.07A$

$E = 20(0.07) + 0.07A \Rightarrow E - 0.17r = 1.4.$ …. (2)

From (1) and (2), 0.05r = 0.2 $\Rightarrow r = \frac{0.2}{0.05} = 4\Omega$

From (1)

E = 1.2 + 0.12 (4)

$= 1.2 + 0.48 = 1.68V$

2. A cell in an open circuit has emf of 2.0 V and in a closed circuit having a current of 0.05A. The p.d is 1.5V. Calculate the internal resistance of the cell.

A. E = 2V ; V = 1.5 V ; i = 0.06

From E – V = ir

$$r = \frac{E-V}{i} = \frac{2-1.5}{0.05} = \frac{0.5}{0.05}$$

3. A battery of emf 6V and internal resistance $1\Omega$ gives a p.d of 5.8 V, when connected to a resistance. Find the external resistance.

A. $E = 6V; r = 1\Omega; V = 5.8V; R = ?$

$$i = \frac{E}{R+r} = \frac{V}{R} \Longrightarrow \frac{6}{R+1} = \frac{5.8}{R}$$

$$6R = 5.8R + 5.8$$

$$\therefore R = 29\Omega$$

4. A cell of e.m.f 2V and internal resistance $1\Omega$ is connected to a potentiometer wire of length 1m and resistance $4\Omega$. Calculate the potential drop per cm.

A. L = 1 meter; R = $1\Omega$, Emf = 2V

P.D. across the total wire = IR = $\frac{E}{R+r}R = \left(\frac{2}{4+1}\right)4 = \frac{8}{5}$

P.D. across 1m = $\frac{8}{5} Volt$

P.D. across cm = $\left(\frac{8}{5}\right) \times \frac{1}{100} = 1.6 \times 10^{-2} V/cm$

5. An ideal battery passes a current of 5 A through a resistor. When it is connected to another resistance $10\Omega$ in parallel, the current is 6 A. Find the resistance of the first resistor.

A. $i_1 = 5A; R = ?, i_2 = 6A; R_2 = 10\Omega$ in parallel

$$v = same \quad \Rightarrow \quad i_1 R_1 = i_2 \left(\frac{10R_1}{10+R_2}\right)$$

$$\Rightarrow 5R_1 = 6\left(\frac{10R_1}{10+R_1}\right) \quad \Rightarrow \quad \mathrm{R} = 2\Omega$$

6. In hydrogen atom, an electron moves in an orbit of radius $5\times10^{-11}m$ with a speed of $2.2\times10^{6}ms^{-1}$. Calculate the equivalent current.

A. $r = 5\times10^{-11}m; v = 2.2\times10^{6} m/s \; i = ?;$

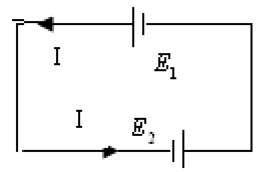
$$i = \frac{e}{t} = \frac{ev}{2\pi r} \quad \Rightarrow i = \frac{1.6\times10^{-19}\times2.2\times10^{6}\times7}{2\times5\times10^{-11}\times22}$$

$i = 1.12mA$

7. Two cells emf $E_1$ and $E_2$ are connected in series in a circuit. Let $r_1$ *and* $r_2$ be the internal resistances of the cells. Find the current through the circuit.

A. Net $EMF = E_1 + E_2$

Total resistance $= r_1 + r_2$

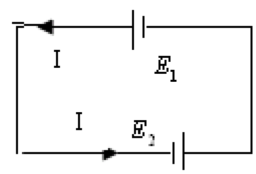



Current = $I = \frac{Net\ EMF}{Total\ resistance} = \frac{E_1 + E_2}{r_1 + r_2}$

8. Let two cells of emf's $E_1$ and $E_2$ are connected in parallel in a circuit. Let $r_1$ *and* $r_2$ be the internal resistance of the cells. Find the value of the current.

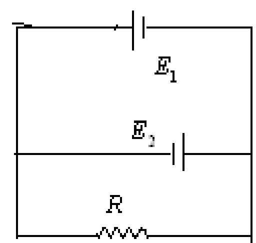
A. $Net\ EMF = E_1 - E_2$

Total resistance $= r_1 + r_2$




Current = $I = \frac{Net\ EMF}{Total\ resistance} = \frac{E_1 - E_2}{r_1 + r_2}$

9. Let two cells of emfs $E_1$, and $E_2$ and internal resistances $r_1$ *and* $r_2$ be connected in parallel to a circuit with an external resistance R. Find the value of the current through the given resistor.




A. Let $I_1$ and $I_2$ be the currents in the cells.

Terminal voltage across $E_1 =$ Terminal voltage across $E_2 =$ P.D across R = V

i.e $E_1 - I_1 r_1 = V \Rightarrow E_1 - V = I_1 r_1 \,(or)\, I_1 = = \frac{E_1 - V}{r_1}$

Similarly, $I_2 = = \frac{E_2 - V}{r_2}$

V = IR And $I = I_1 + I_2$

$$\Rightarrow I = \frac{E_1 - IR}{r_1} + \frac{E_2 - IR}{r_2} = \frac{E_1}{r_1} - \frac{IR}{r_1} + \frac{E_2}{r_2} - \frac{IR}{r_2} \qquad \Rightarrow \quad I = \frac{E_1 r_2 + E_2 r_1}{r_1 r_2 + R(r_1 + r_2)}$$

11. Two electric bulbs have their resistance in the ratio 2 : 3. They are connected a) first in series and then b) in parallel across the same voltage. Find the ratio of powers consumed by each of the two bulbs in the two combinations.

A. $\frac{R_1}{R_2} = \frac{2}{3}$

(a) Series

$$P = I^2R \qquad ( \text{'I' is constant} )$$

$$\Rightarrow \frac{P_1}{P_2} = \frac{R_1}{R_2} = \frac{2}{3}$$

(b) Parallel

$$P = \frac{V^2}{R} \qquad (\text{'V' is constant})$$

$$\Rightarrow \frac{P_1}{P_2} = \frac{R_2}{R_1} = \frac{3}{2}$$

12. Three equal resistors connected in series across a source of emf together dissipate 10 W power. Find the power dissipated if the same resistors are connected in parallel.

A. In series, Total resistance $R_s = R + R + R = 3R$

$$P_1 = \frac{V^2}{R_s} \Rightarrow P_1 = \frac{v^2}{3R} = 10$$

In parallel, total resistance = $R_p = \frac{R}{3}$

$$P_2 = \frac{V}{R_p} = \frac{V^2}{\left(\frac{R}{3}\right)} = \frac{3V^2}{R}$$

$$\Rightarrow \frac{P_2}{P_1} = \frac{\left(\frac{3V^2}{P}\right)}{\left(\frac{V}{3R}\right)} = 9 \Rightarrow P_2 = 9P_1 = 9 \times 10 = 90w$$

13. Ten 50W bulbs are operated on an average for 10 hours a day. Find the energy consumed in KWh in one month of 30 days.

A, Energy consumed by 10 bulbs in 1 day $= 50 \times 10^{-3} \times 10 \times 10 = 5KWh$

Energy consumed in 30 days $= 5 \times 10 = 150KWh$

14. Two electric lamps of 40 W each are connected in parallel across the mains supply. Find the total power consumed by the two bulbs together.

A. In parallel, P.D. is common i.e. $V_1 = V_2 = V$

$$P = VI \Rightarrow I = \frac{P}{V}$$

$$I = I_1 + I_2$$

$$\Rightarrow \frac{P}{V} = \frac{P_1}{V_1} + \frac{P_2}{V_2} \Rightarrow P = P_1 + P_2 = 40 + 40 = 80 \text{ w}$$

15. A bulb rated 100 w, 220 V is connected across 110 V mains line. Find the power consumed.

A. P = 100 w ; V = 220v

Resistance $R = \frac{V^2}{P} = \frac{220 \times 220}{100} = 484\Omega$

Power consumed $= \frac{(V)^2}{R} = \frac{110 \times 110}{484} = 25W$

16. Two heater coils separately take 10 minutes and 5 minutes to boil a certain amount of water. Find the time taken by both the coils connected in series to boil the same amount of water.

A. $t_1 = 10\min \;\; and \;\; t_2 = 5\min$

From $H = \frac{V^2}{R}t \;\; \Rightarrow t \alpha R$ in series

Since $R = R_1 + R_2 \Rightarrow t = t_1 + t_2 = 10 + 5 = 15\min$

17. Two cells A and B each of emf 2V are connected in series to an eternal resistance. R = 1 ohm. The internal resistance of A is $r_A = 1.9$ ohm and of B is $r_B = 0.9 ohm.$ Find the potential difference between the terminals of cell A.

A. $E = 2V$ ; $R = 1\Omega$ ; $r_A = 1.9\Omega$ ; $r_B = 0.9\Omega$

$$I = \frac{EMF}{Total\ resis\tan ce} = \frac{4}{R + r_A + r_B} = \frac{4}{1 + 1.9 + 0.9} = \frac{2}{1.9}A$$

$$V_A = E - Ir_A = 2 - \left(\frac{2}{1.9}\right)(1.9) = 2 - 2 = 0V$$

18. When a resistor of $11\Omega$ is connected in series with an electric cell, 0.5A current flows through it. If the $11\Omega$ resistor is replaced by $5\Omega$ resistor, the current flowing through it will be 0.9 A. Find the internal resistance of the cell .

A. E = V + Ir = IR + Ir

When $R = 11\Omega, I = 0.5A$

$E = 0.5(11) + 0.5r$ …. (1)

When $R = 5\Omega, I = 0.9\Omega$

$\Rightarrow E = 0.9(5) + 0.9r$ …. (2)

From (1) & (2)

$5.5 + 0.5r = 4.5 + 0.9r$

$$\Rightarrow 0.4r = 1 \Rightarrow r = \frac{1}{0.4} = \frac{10}{4} = 2.5\Omega$$

19. Two cells A and B with same emf of 2 V each and with internal resistances $r_A = 3.5\Omega$ *and* $r_B = 0.5\Omega$ are connected in series with an external resistance $R = 3\Omega$. Fin the terminal voltages across the two cells.

A. Total EMF = E+E = 2+2 = 4v ; $R = 3\Omega$

$r_A = 3.5\Omega$ ; $r_B = 0.5\Omega$

$$I = \frac{E}{R + r_A + r_B} = \frac{4}{3 + 3.5 + 0.5} = \frac{4}{7} A$$

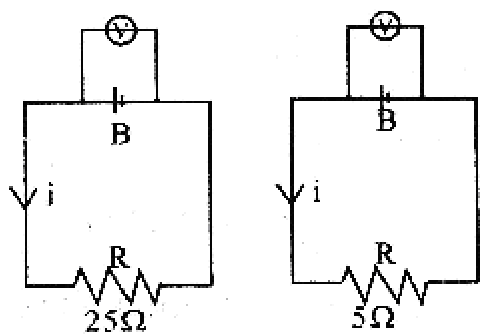
$$V_A = E - Ir_A = 2 - \left(\frac{4}{7}\right)(3.5) = 0V$$

$$V_B = E - Ir_B = 2 - \left(\frac{4}{7}\right)(0.5) = \frac{12}{7}$$

$$V_B = 1.714v$$

**<u>ASSESS YOURSELF</u>**

**1. A battery B of emf 1.5V and internal resistance $r = 5\Omega$ is first connected across a resistor of resistance $25\Omega$ as in figure 6.10(a). Next, the same battery is connected across a resistor of resistance $5\Omega$ as in figure 6.10(b). In which case, the voltmeter reading will be higher ?**




**A.** In the first case $i = \frac{1.5}{5+25} = \frac{1.5}{30}$ and

$$V = 1.5 - \left(\frac{1.5}{30}\right)5 = 1.5 - 0.25 = 1.25V \quad \ldots\ldots\ldots(1)$$

In the second case $i = \frac{1.5}{5+5} = \frac{1.5}{10}$ and $V = \frac{1.5}{10}$ and $V = 1.5\left(\frac{1.5}{10}\right)5 = 0.75V$

$$i = \frac{1.5}{5+5} = \frac{1.5}{10} \text{ and } V = 1.5 - \left(\frac{1.5}{10}\right)5 = 0.75V \quad \ldots\ldots\ldots(2)$$

The voltmetre reading is higher in the first case.