UNIT II

CURRENT ELECTRICITY

Weightage : 07 Marks

TOPICS TO BE COVERED

Electric current; flow of electric charges in a metllic conductor, drift velocity, mobility and their relation with electric current. Ohm's law electrical resistance, V-I characteristics (linear and non-linear)

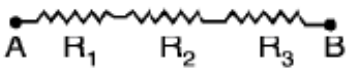
Electrical energy and power, Electrical resistivity and connectivity, carbon resistors, colour code for carbon resistors; Series and parallel combinations of resistors; temperature dependence of resistance.

Internal resistance of a cell, potential difference and emf of a cell. Combination of cells in series and in parallel.

Kirchhoff's laws and simple applications, wheatstone bridge, metre bridge.

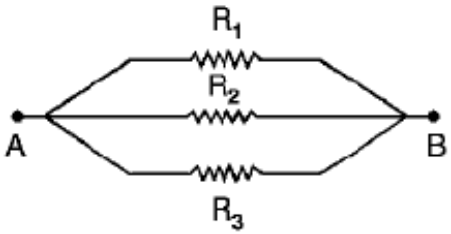
Potentiometer-principle and its applications to measure potential difference and for comparing emf of two cells, measurement of internal resistance of a cell.

CURRENT ELECTRICITY
IMPORTANT FORMULA

1.	Drift Velocity	$\vec{V}_d = -\frac{e\vec{E}}{m}\tau$	$\vec{E}$ – electric fuld τ = Relaxation time
2.	Relation b/w current and Drift Velocity	$I = enAV_d$	e = charge on electrons m = mass of electron n = number density of electrons
3.	Ohm's Law	$V = RI$	A = cross Section Area
4.	Resistance	$R = \frac{\rho l}{A}$	V = potential difference across conductor
5.	Specific Resistance or Resistivity	$\rho = \frac{RA}{\rho} = \frac{m}{ne^2\tau}$	l = length of conductor
6.	Current density	$j = I/A = neV_d$	
7.	Electrical Conductivity	$\sigma = 1/\rho$	
8.	Resistances in Series	$R_{eq} = R_1 + R_2 + R_3$	

Parallel

$$\frac{1}{R_{eq}}=\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}$$



9. Temperature Dependance of Resistance

$$R_t = R_o(1 + \alpha t)$$

10. Internal Resistance of a cell

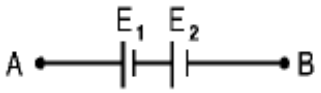
$$r=\left(\frac{E}{V}-1\right)R$$

11. Power

$$\ldots\ldots I^2R = \frac{V^2}{R}$$

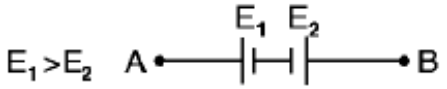
12. Cells in Series

$$Eeq = E_1 + E_2$$



Equivalent emf

$$Eeq = E_1 - E_2$$



Equivalent Internal Resistance

$$req = r_1 + r_2$$

E_1 & E_2 are emf of two cells r_1 and r_2 are their internal resistances respectively

	Equivalent Current	$I=\frac{nE}{R+nr}$	n = no. of cells in series.
13.	Cells in parallel	Equivalent e.m.f $E_{eq}=\frac{E_1r_2+E_2r_1}{r_1+r_2}$ Equivalent resistance $r_{eq}=\frac{r_1r_2}{r_1+r_2}$	
	Equivalent Current	$I=\frac{mE}{mR+r}$	m = number of cells in parallel
14.	Kirchoff's Laws	$\Sigma i = o$ (at a junction) $\Sigma iR = \Sigma E$ (in a closed loop)	i = Current R = Resistance E = e.m.f.
15.	Wheatstone Bridge (balanced condition)	$\frac{P}{Q}=\frac{R}{S}$	P,Q,R and S are resistances in Ohm in four arms of Wheatstone Bridge.
16.	Slide wire Bridge or metre Bridge	$S=\left(\frac{100-l}{l}\right)R$	
17.	Potentiometer		

Comparison of Emf	$\frac{E_1}{E_2}=\frac{l_1}{l_2}$	l_1 and l_2 are balancing lengths on polentiometer wire for cells E_1 and E_2
Internal Resistance	$r=\left(\frac{l_1-l_2}{l_2}\right)R$ $=\left(\frac{E}{V}-l\right)R$	l_1 and l_2 are balancing lengths on polentiometer wire in open circuit and closed circuit.

QUESTIONS

VERY SHORT ANSWER QUESTIONS (1 Mark)

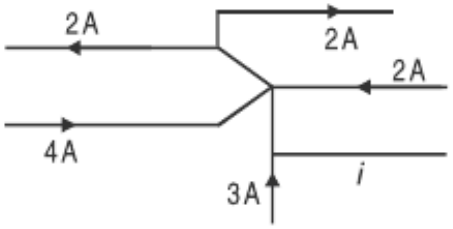
1. How does the relaxation time of electron in the conductor change when temperature of the conductor decreases.

2. Sketch a graph showing variation of resistivity with temperature of (i) Copper (ii) Carbon.

3. The emf of the driver cell (Auxillary battery) in the potentiometer experiment should be greater than emf of the cell to be determined. Why?

4. You are required to select a carbon resistor of resistance 47kΩ ± 10% from a large collection. What should be the sequence of color bands used to code it?

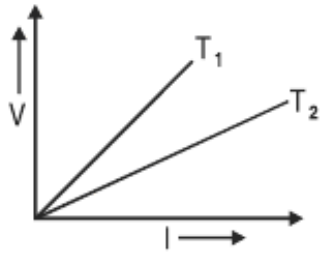
5. The fig. here shows a part of a circuit. What are the magnitude and direction of the current *i* in the lower right-hand wire? (8 Amp)



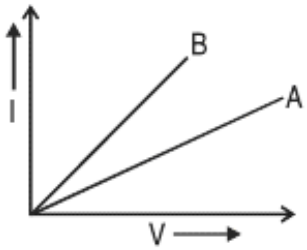
6. Two wire one of copper and other of manganin have same resistance and equal length. Which wire is thicker?

7. You are given three constantan wires P, Q and R of length and area of cross-section (L, A), $\left(2L, \frac{A}{2}\right)$ and $\left(\frac{L}{2}, 2A\right)$ respectively. Which has highest resistance?

8. V – I graph for a metallic wire at two different temperatures T_1 and T_2 is as shown in the figure. Which of the two temperatures is higher and why?



9. Out of V – I graph for parallel and series combination of two metallic resistors, which one represents parallel combination of resistors? Justify your answer.

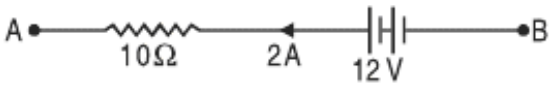


10. Why is the potentiometer preferred to a voltmeter for measuring emf of a cell?

11. How can a given 4 wires potentiometer be made more sensitive?

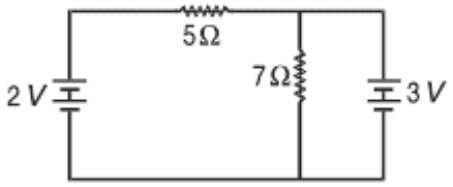
12. Why is copper not used for making potentiometer wires?

13. In the figure, what is the potential difference between A and B?

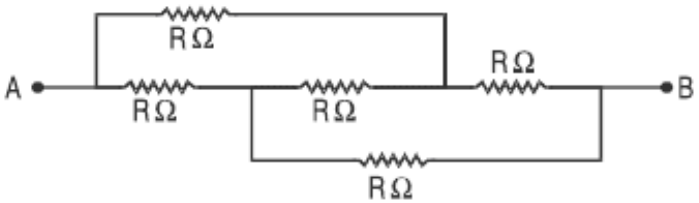


14. A copper wire of resistance R is uniformally stretched till its length is increased to n times its original length. What will be its new resistance?

15. Two resistances 5Ω and 7Ω are joined as shown to two batteries of emf 2V and 3V. If the 3V battery is short circuited. What will be the current through 5Ω?



16. Calculate the equivalent resistance between points A and B in the figure given below.



17. What is the largest voltage that can be safely put across a resistor marked 196Ω, 1W?

18. When does the terminal voltage of a cell become (i) greater than its emf (ii) less than its emf?

19. A car battery is of 12V. Eight dry cells of 1.5 V connected in series also give 12V, but such a combination is not used to start a car. Why?

20. Two electric lamps A and B marked (220V, 100W) and (220V, 60W) respectively. Which of the two lamps has higher resistance?

21. Constantan is used for making the standard resistance. Why?

22. A 16Ω thick wire is stretched so that its length becomes two times. Assuming there is no change in density on stretching. Calculate the resistance of new wire.

23. State the Condition under which the terminal potential difference across a battery and its emf are equal.

24. State the Condition for maximum current to be drawn from the Cell.

25. Name the physical quantity measured by potential gradient.

SHORT ANSWER QUESTIONS (2 Marks)

1. Define mobility of electron in a conductor. How does electron mobility change when (i) temperature of conductor is decreased (ii) Applied potential difference is doubled at constant temperature?

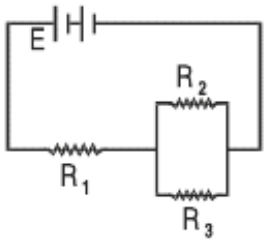
2. On what factor does potential gradient of a potentiometer wire depend?

3. What are superconductors? Give one of their applications.

4. Two manganin wires whose lengths are in the ratio 1 : 2 and whose resistances are in the ratio 1 : 2 are connected in series with a battery. What will be the ratio of drift velocities of free electrons in the two wires?

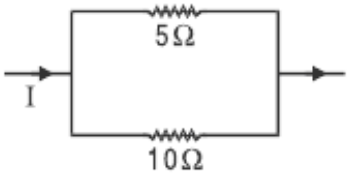
5. The current through a wire depends on time as $i = i_0 + at$ where $i_0 = 4A$ and $a = 2As^{-1}$. Find the charge crossing a section of wire in 10 seconds.

6. Three identical resistors R_1, R_2 and R_3 are connected to a battery as shown in the figure. What will be the ratio of voltages across R_1 and R_2. Support your answer with calculations. (2:1)



7. In the arrangement of resistors shown, what fraction of current I will pass through 5Ω resistor?

$\left(\frac{2I}{3}\right)$



8. A 100W and a 200 W domestic bulbs joined in series are connected to the mains. Which bulb will glow more brightly? Justify. (100W)

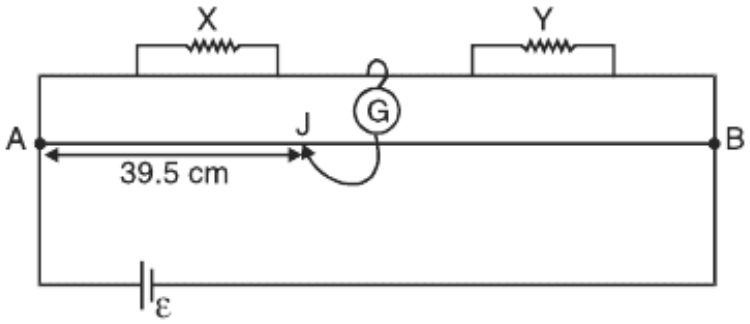
9. A 100W and a 200 W domestic bulbs joined in parallel are connected to the mains. Which bulb will glow more brightly? Justify. (200W)

10. A battery has an emf of 12V and an internal resistance of 2Ω. Calculate the potential difference between the terminal of cell if (a) current is drawn from the battery (b) battery is charged by an external source.

11. A uniform wire of resistance R ohm is bent into a circular loop as shown in the figure. Compute effective resistance between diametrically opposite points A and B. [**Ans.** R/4]

12. In a potentiometer arrangement, a cell of emf 1.25V gives a balance point at 35 cm length of the wire. If the cell is replaced by another cell, then the balance point shifts to 63 cm. What is the emf of the second cell?
[**Ans.** 2.25V]

13. In a meter bridge, the balance point is found to be 39.5 cm from end A. The known resistance Y is 12.5Ω. Determine unknown resistance X.
[**Ans.** 8.16Ω]



14. A meterbridge is in balance condition. Now if galvanometer and cell are interchanged, the galvanometer shows no deflection. Give reason.

    [**Ans.** Galvanometer will show no deflection. Proportionality of the arms are retained as the galvanometer and cell are interchanged.]

15. If the emf of the driving cell be decreased. What will be effect on the position of zero deflection in a potentiometer.

16. Why should the area of cross section of the meter bridge wire be uniform? Explain.

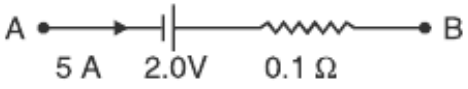
17. Given any two limitations of Ohm's law.

18. Which one of the two, an ammeter or a milliammeter has a higher resistance and why?

19. Name two factors on which the resistivity of a given material depends? A carbon resistor has a value of 62kΩ with a tolerance of 5%. Give the colour code for the resistor.

20. If the electron drift speed is so small (~10^{-3} m/s) and the electron's charge is very small, how can we still obtain a large amount of current in a conductor

21. A battery of emf 2.0 volts and internal Resistance 0.1Ω is being charged with a current of 5.0A. Whatis the potential difference between the terminals of the battery?



22. Why should the jockey be not rubbed against potentiometer wire?

23. What is meant by the sensitivity of a potentiometer of any given length?

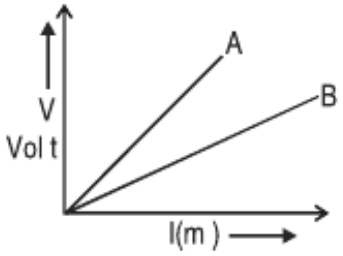
SHORT ANSWER QUESTIONS (3 Marks)

1. Define specific resistance. Write its SI unit. Derive an expression for resistivity of a wire in terms of its material's parameters, number density of free electrons and relaxation time.

2. A potential difference V is applied across a conductor of length L and diameter D. How are the electric field E and the resistance R of the conductor affected when (i) V is halved (ii) L is halved (iii) D is doubled. Justify your answer.

*3. Define drift velocity. A conductor of length L is connected to a dc source of emf E. If the length of conductor is tripled by stretching it, keeping E constant, explain how do the following factors would vary in the conductor? (i) Drift speed of electrons (ii) Resistance and (iii) Resistivity.

4. Define potential gradient. How can potential gradient of a potentiometer be determined experimentally. In the graph shown here, a plot of potential drop versus length of the potentiometer is made for two potentiometers. Which is more sensitive –A or B?

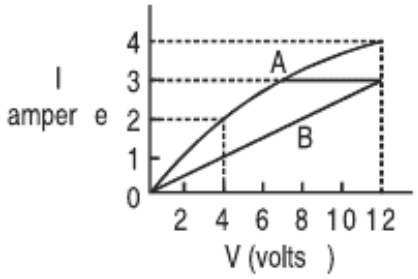


*5. Define conductivity of a substance. Give its SI units. How does it vary with temperature for (i) Copper (ii) Silicon?

*6. State the principle of potentiometer. Drawa circuit diagram used to compare the emf of two primary cells. Write the formula used.

7. The graph shows how the current I varies with applied potential difference V across a 12 V filament lamp (A) and across one metre long nichrome wire (B). Using the graph, find the ratio of the values of the resistance of filament lamp to the nichrome wire

   (i) when potential difference across them is 12 V.



(ii) when potential difference across them is 4V. Give reason for the change in ratio of resistances in (i) and (ii).

8. Electron drift speed is estimated to be only a few mm/s for currents in the range of few amperes? How then is current established almost the instant a circuit is closed.

9. Give three points of difference between e.m.f and terminal potential difference of a cell.

10. Define the terms resistivity and conductivity and state their S.I. units. Draw a graph showing the variation of resistivity with temperature for a typical semiconductor.

11. The current flowing through a conductor is 2mA at 50V and 3mA at 60V. Is it an ohmic or non-ohmic conductor? Give reason.

12. Nichrome and copper wires of same length and area of cross section are connected in series, current is passed through them why does the nichrome wire get heated first?

13. Under what conditions is the heat produced in an electric circuit:

(i) directly proportional

(ii) inversely proportional to the resistance of the circuit

LONG ANSWER QUESTIONS (5 Marks)

1. State Kirchhoff's rules for electrical networks. Use them to explain the principle of Wheatstone bridge for determining an unknown resistance. How is it realized in actual practice in the laboratory? State the formula used.

2. Define emf and terminal potential difference of a cell. When is the terminal charging potertial difference greaterthan emf? Explainhow emf and terminal

potential difference can be compared using a potentiometer and hence determine internal resistance of the cell.

3. For three cells of emf E_1, E_2 and E_3 with internal resistances r_1, r_2, r_3 respectively connected in parallel, obtain an expression for net internal resistance and effective current. What would be the maximum current possible if the emf of each cell is E and internal resistance is r each?

4. Derive an expression for drift velocity of the electron in conductor. Hence deduce ohm's law.

5. State the principle of potentiometer. How can it be used to :

   (i) Compare e.m.f of two cells

   (ii) Measure internal resistance of a cell?

6. Explain how does the conductivity of a :

   (i) Metallic conductor

   (ii) Semi conductor and

   (iii) Insulator varies with the rise of temperature.

7. Derive expression for equivalent e.m.f and equivalent resistance of a :

   (a) Series combination

   (b) Parallel combination

   of three cells with e.m.f E_1, E_2, E_3 & internal resistances r_1, r_2, r_3 respectively.

8. Deduce the condition for balance in a Wheatstone bridge. Using the principle of Wheatstone bridge, describe the method to determine the specific resistance of a wire in the laboratory. Draw the circuit diagram and write the formula used. Write any two important precautions you would observe while performing the experiment.

NUMERICALS

1. The charge passing through a conductor is a function of time and is given as $q = 2t^2 - 4t + 3$ milli coulomb. Calculate (i) Current through the conductor (ii) Potential difference across it at t = 4 second. Given resistance of conductor is 4 ohm. **[Ans. :** I = 12A, V = 48 V]

2. The resistance of a platinum wire at a point 0°C is 5.00 ohm and its

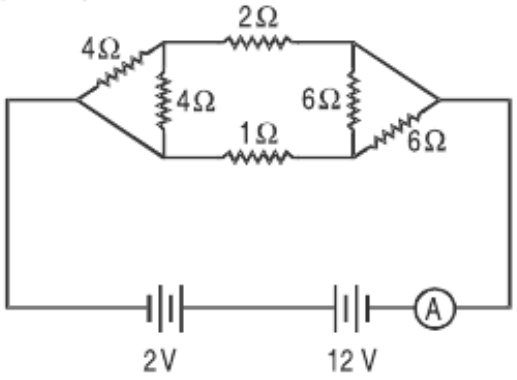
resistance at steam point is 5.40Ω. When the wire is immersed in a hot oil bath, the resistance becomes 5.80Ω. Calculate the temperature of the oil bath and temperature coefficient of resistance of platinum.

[**Ans. :** a = 0.004°C; T = 200°C]

3. Three identical cells, each of emf 2V and internal resistance 0.2 ohm, are connected in series to an external resistor of 7.4 ohm. Calculate the current in the circuit and the terminal potential difference across an equivalent cell.

[**Ans. :** I = 0.75; V = 5.55 V]

4. Calculate the equivalent resistance and current shown by the ammeter in the circuit diagram given. [**Ans. :** R = 2Ω; I = 5A]



5. A storage battery of emf 12V and internal resistance of 1.5Ω is being charged by a 12V dc supply. How much resistance is to be put in series for charging the battery safely, by maintaining a constant charging current of 6A. [**Ans. :** R = 16.5Ω]

6. Three cell are connected in parallel, with their like poles connected together, with wires of negligible resistance. If the emf of the cell are 2V, 1V and 4 V and if their internal resistance are 4Ω, 3Ω and 2 ohm respectively, find the current through each cell.

$$\left[\textbf{Ans. :}\ I_1 = \frac{-2}{13}A,\ I_2 = \frac{-7}{13}A,\ I_3 = \frac{9}{13}A\right]$$

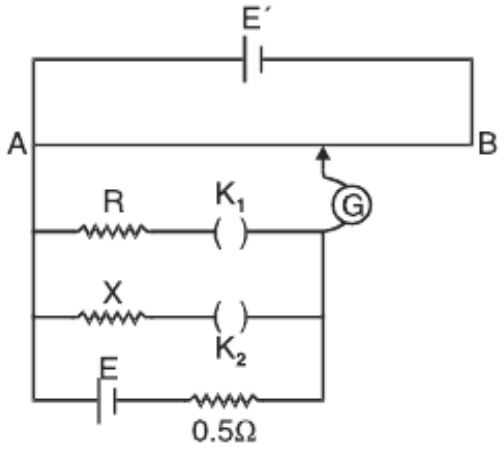
7. A 16 ohm resistance wire is bent to form a square. A source of emf 9 volt is connected across one of its sides. Calculate the potential difference across any one of its diagonals. [**Ans. :** 1V]

8. A length of uniform 'heating wire' made of nichrome has a resistance 72Ω. At what rate is the energy dissipated if a potential difference of 120V is applied across (a) full length of wire (b) half the length of wire (wire is cut into two). Why is it is not advisable to use the half length of wire?

[**Ans. :** (a) 200W (b) 400W. 400W >> 200W but since current becomes large so it is not advisable to use half the length]

9. With a certain unknown resistance X in the left gap and a resistance of 8Ω in the right gap, null point is obtained on the metre bridge wire. On putting another 8Ω in parallel with 8Ω resistance in the right gap, the null point is found to shift by 15cm. Find the value of X from these observations. [**Ans. :** 8/3Ω]

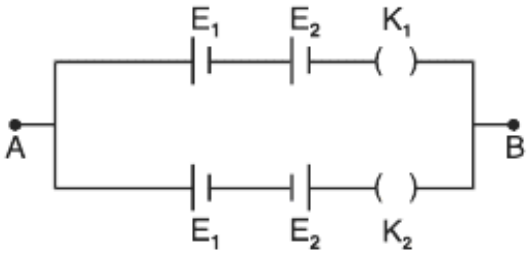
10. Figure show a potentiometer circuit for comparison of two resistances. The balance point with a standard resistance R = 10Ω is found to be 160 cm. While that with the unknown resistance X is 134.4 cm. Determine the value of X. [**Ans. :** 2Ω]



11. Two cells of E.M.F. E_1 and E_2 ($E_1 > E_2$) are connected as shown in figure. Potentiometer is connected between points A and B. Calculate the ratio of E_1 and E_2 when

    (a) K_1 is closed and K_2 is open

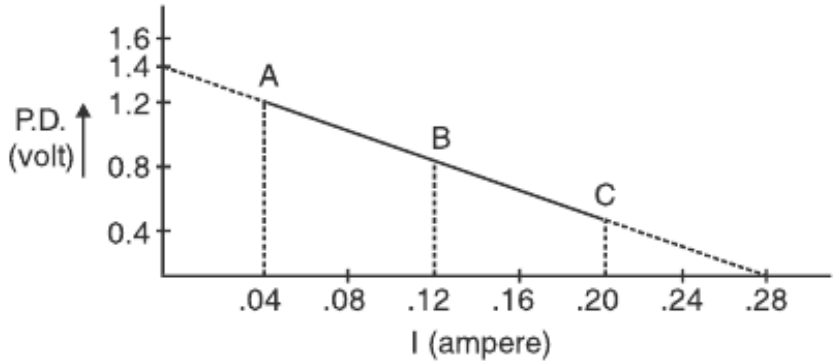
    (b) K_1 is open and K_2 is closed [**Ans. :** 2:1]



12. Potential difference across terminals of a cell are measured (in volt) against different current (in ampere) flowing through the cell. A graph was drawn

which was a straight line ABC. Using the data given in the graph, determine (i) the emf. (ii) The internal resistance of the cell.

[**Ans. :** $r = 5\Omega$ emf = 1.4V]

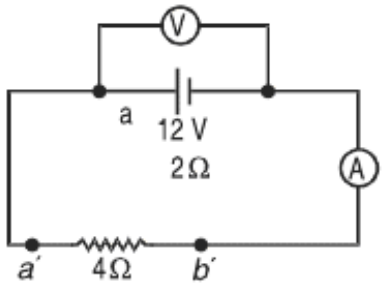


13. Four cells each of internal resistance 0.8Ω and emf 1.4V, *d* are connected (i) in series (ii) in parallel. The terminals of the battery are joined to the lamp of resistance 10Ω. Find the current through the lamp and each cell in both the cases.

[**Ans. :** Is = 0.424A, Ip = 0.137A current through each cell is 0.03A]

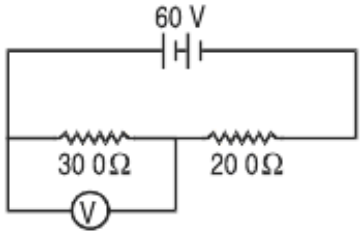
14. In the figure an ammeter A and a resistor of resistance $R = 4\Omega$ have been connected to the terminals of the source to form a complete circuit. The emf of the source is 12V having an internal resistance of 2Ω. Calculate voltmeter and ammeter reading.

[**Ans. :** Voltmeter reading : 8V, Ammeter reading = 2A]

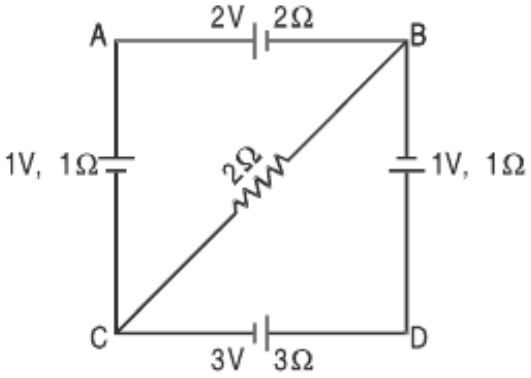


15. In the circuit shown, the reading of voltmeter is 20V. Calculate resistance of voltmeter. What will be the reading of voltmeter if this is put across 200Ω resistance?

[**Ans. :** $R_V = 150\Omega$; $V = \frac{40}{3}V$]

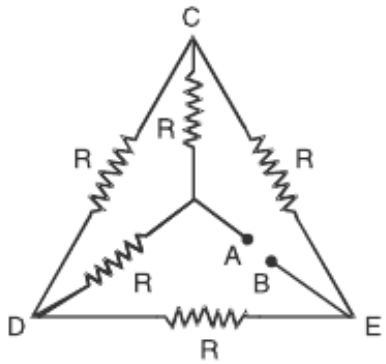


16. For the circuit given below, find the potential difference b/w points B and D. [**Ans. :** 1.46 Volts]

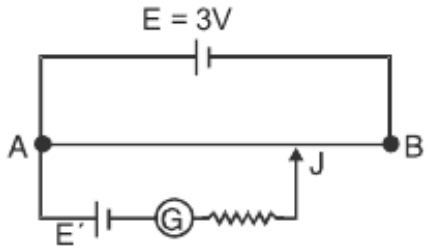


17. (i) Calculate Equivalent Resistance of the given electrical network b/w points A and B.

(ii) Also calculate the current through CD & ACB if a 10V d.c source is connected b/w point A and B and the value of R = 2Ω



18. A potentiometer wire AB of length 1m is connected to a driver cell of emf 3V as shown in figure. When a cell of emf 1.5V is used in the secondary circuit, the balance point is found to be 60 cm. On replacing this cell by a cell of unknown emf, the balance point shifts to 80cm :



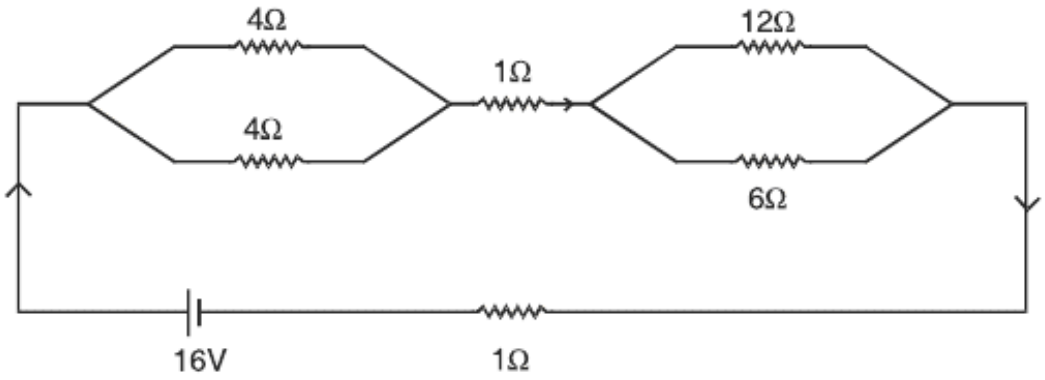
(i) Calculate unknown emf E' of the Cell.

(ii) Explain with reason, whether the circuit works if the driver cell is replaced with a cell of emf IV.

(iii) Does the high resistance R, used in the secondary circuit affect the balance point? Justify your answer.

19. A battery of emf 10V and internal resistance 3Ω is connected to a resistor. If the current in the circuit is 0.5A, what is the resistance of the resistor? What is the terminal voltage of the battery when the circuit is closed?

20. A network of resistances is connected to a 16V battery with internal resistance of 1Ω as shown



(i) Compute the Equivalent Resistance of the network.

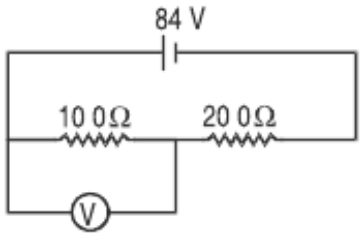
(ii) Obtain the current in each resistor.

(iii) Obtain the voltage drop V_{AB}, V_{BC} & V_{CD}.

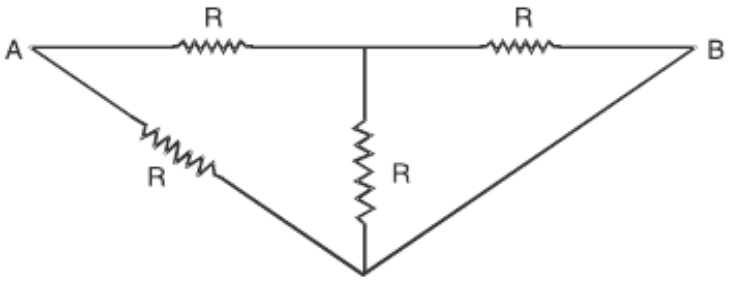
21. The number density of conduction electrons in a Copper Conductor estimated to be 8.5×10^{28} m^{-3}. How long does an electron take to drift from one end of a wire 3.0m long to its other end? The area of cross section of the wire is 2.0×10^{-6} m^2 and it is carrying a current of 3.0 A.

22. A Voltmeter of resistance 400Ω is used to measure the potential difference

across the 100Ω resistor in the circuit shown in figure. What will be the reading of voltmeter.



23. The Equivalent Resistance between points A and B of the adjoing circuit.



HOTS

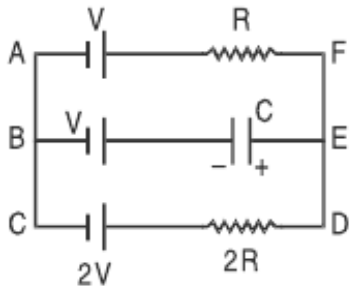
SHORT ANSWER QUESTIONS (2 Marks)

1. Five identical cells, each of emf E and internal resistance *r*, are connected in series to form (a) an open (b) closed circuit. If an ideal voltmeter is connected across three cells, what will be its reading?

[**Ans.** : (a) 3E; (b) zero]

2. An electron in a hydrogen atom is considered to be revolving around a proton with a velocity $\frac{e^2}{n}$ in a circular orbit of radius $\frac{n^2}{me^2}$. If I is the equivalent current, express it in terms of m, e, n $\left(n = \frac{h}{2\pi}\right)$. $\left(\frac{me^5}{2\pi n^3}\right)$

3. In the given circuit, with steady current, calculate the potential drop across the capacitor in terms of V.



4. A cell of e.m.f. 'E' and internal resistance 'r' is connected across a variable resistor 'R'. Plot a graph showing the variation of terminal potential 'V' with resistance 'R'. Predict from the graph the condition under which 'V' becomes equal to 'E'.

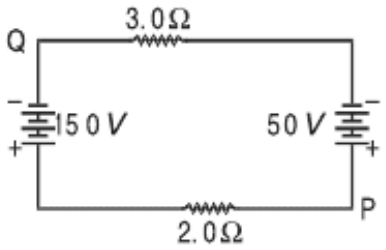
NUMERICALS

1. A copper wire of length 3m and radius r is nickel plated till its radius becomes $2r$. What would be the effective resistance of the wire, if specific resistance of copper and nickel are ρ_c and ρ_n respectively.

[**Hint. :** $P_c = P_e \frac{l}{\pi r^2}$;l $\quad R_n = n\frac{l}{\pi (2r)^2 - \pi r^2}$

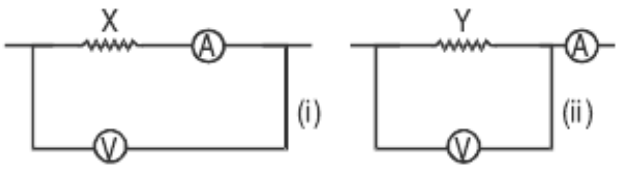
$R = \frac{R_C R_n}{R_C + R_n}$. $\quad$ [**Ans. :** $R = \frac{3\rho_n \rho_c}{\pi r^2 (3\rho_c + \rho_n)}$]

2. In the figure, if the potential at point P is 100V, what is the potential at point Q?



[**Ans. :** – 10V]

3. Given two resistors X and Y whose resistances are to be determined using an ammeter of resistance 0.5Ω and a voltmeter of resistance 20 kΩ. It is known that X is in the range of a few ohms, while Y is in the range of several thousand ohm. In each case, which of the two connection shown should be chosen for resistance measurement?



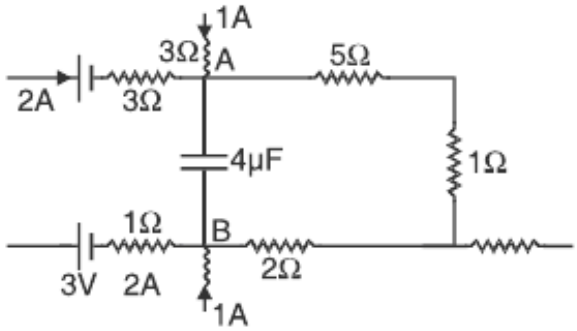
[**Ans. :** Small resistance : X will be preferred; large resistance : Y will be preferred]

4. When resistance of 2Ω is connected across the terminals of a battery, the current is 0.5A. When the resistance across the terminal is 5Ω, the current is 0.25A. (i) Determine the emf of the battery (ii) What will be current drawn from the cell when it is short circuited.

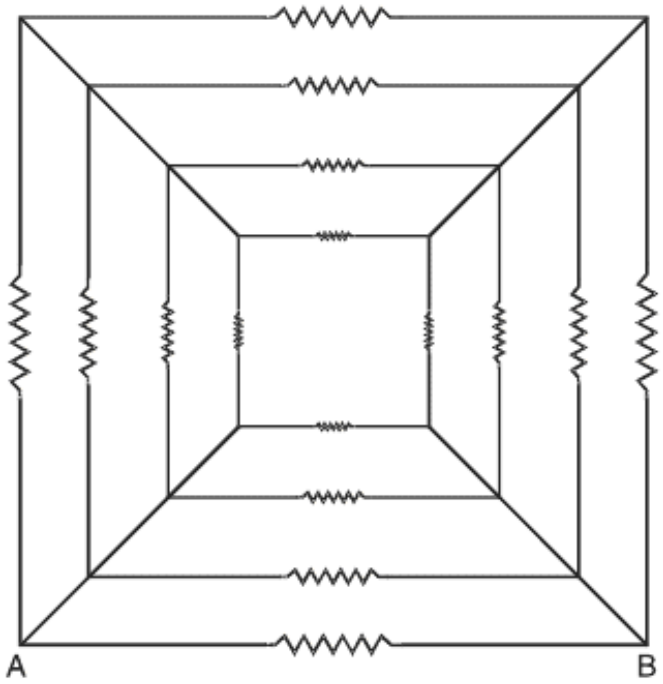
[**Ans. :** E = 1.5V, I = 1.5A]

5. A part of a circuit in steady state, along with the currents flowing in the branches and the resistances, is shown in the figure. Calculate energy stored in the capacitor of 4μF capacitance.

[**Ans. :** V_{AB} = 20V, U = 8 × 10^{-4} J]



*6. Sixteen resistors each of resistance 16Ω are connected in circuit as shown. Calculate the net resistance between A and B. [**Ans.** : 3Ω]

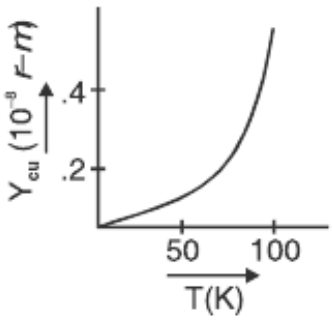


7. A voltmeter with resistance 500Ω is used to measure the emf of a cell of internal resistance 4Ω. What will be the percentage error in the reading of the voltmeter. [**Ans.:** 0.8%]

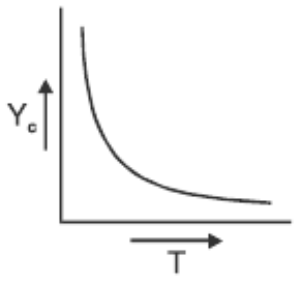
ANSWERS

I MARK QUESTIONS

1. Relaxation time increases.

2. 

For Copper



For Carbon

3. If emf of driver cell is less, then n ull point will not be obtained on the potentiometer wire.

4. Yellow, Violet, Orange, Silver.

5. 8 ampere.

6. $$R = \rho_c \frac{l_c}{a_c} = \rho_m \frac{l_m}{a_m}$$

$$\frac{\rho_c}{\rho_m} = \frac{a_c}{a_m} < 1$$

$\therefore$ managing in thicker.

7. $$R_p = \rho \frac{L}{A}, \; R_Q = \rho \frac{2L.2}{A} = \frac{L4\rho}{A}, \; R_R = \frac{\rho L}{4A}$$

Q has the highest resistance.

8. Slope of T_1 is large so T_1 represents higher temperature as resistance increase with temperature for a conductor; $R = \frac{V}{I}$ = slope.

9. The resistance for parallel combination is lesser than for series combination for a given set of resistors. Hence B will represent parallel combination since I/V for it is more *i.e.,* Resistance $= \frac{V}{I}$ is less.

10. Emf measured by potentiometer is more accurate because the cell is in open circuit, giving no current.

11. By connecting a resistance in series with the potentiometer wire in the primary circuit, the potential drop across the wire is reduced.

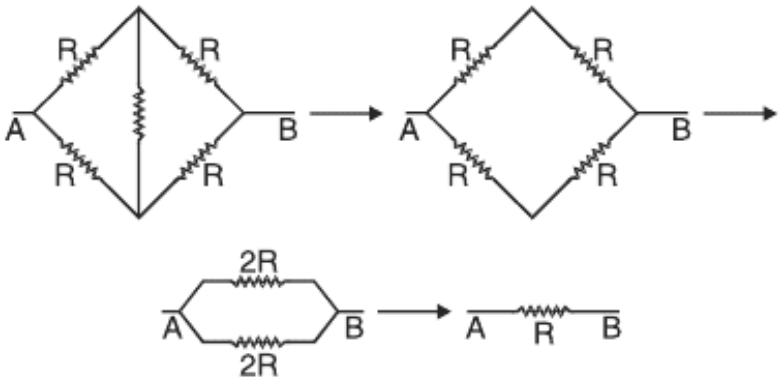
12. Copper has high temperature coefficient of resistance and hence not preferred.

13. $V_A - V_B = -8$ volt.

14. $R' = n^2 R$

15. $I = \frac{2}{5} A$

16.



$\therefore$ Req = R.

17. $$P = \frac{V^2}{R}$$

$V^2 = PR = 1 \times 196 = 196$

V = 14 volt.

18. (i) When the cell is being charged terminal potential difference becomes greater than emf; $V = E + Ir$.

(ii) When the cell is discharged terminal potential is lesser than emf; $V = E - Ir$.

19. Dry cells used in series will have high resistance ($\approx$ 10Ω) and hence provide low current, while a car battery has low internal resistance (0.1Ω) and hence gives high current for the same emf, that is needed to start the car.

20. 220V, 60W lamp has higher resistance as $R = \frac{V^2}{P}$ and hence current reduces.

21. High resistivity and low temperature coefficient of resistance

22. $R = \rho\frac{\ell}{A} = \rho\frac{\ell^2}{Al} = \frac{\rho\ell^2}{V}$ ρ and V are constant

$\therefore R \propto l^2 \therefore \frac{R_1}{R_2} = \left(\frac{\ell_1}{\ell_2}\right)^2$;

$$\frac{16}{R_2}=\left(\frac{\ell_1}{2\ell_2}\right)^2 \quad \therefore\ R_2 = 64\Omega$$

23. When battery is in open circuit *i.e.*, when no current is being drawn from the cell.

24. $I=\frac{E}{R+r}$ External resistance R should be zero, *i.e.*, for maximum current the terminals of a cell must be short circuited.

2 MARKS QUESTIONS

2. $I = \frac{\text{Charge circulating}}{\text{Time for one revolution}} = \frac{e}{3\pi r/v}$ $v \rightarrow$ speed

$$= \frac{e}{2\pi}\frac{e^2/\hbar}{\hbar/me^2} \qquad \hbar = \frac{h}{2\pi}$$

$$= \frac{m e^5}{2\pi \hbar^3}$$

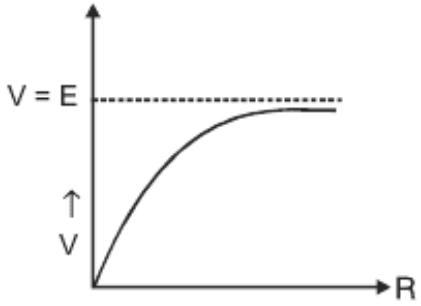
3. In steady state the branch containing C can be omitted hence the current

$$I = \frac{2V - V}{R + 2R} = \frac{V}{3R}$$

For loop EBCDE

$$-V_C - V + 2V - I(2R) = 0$$

$$\Rightarrow \quad V_C = \frac{V}{3}$$



4. $V = IR = \dfrac{ER}{R + r} = \dfrac{E}{\dfrac{r}{R} + 1}$

   When R approaches infinity V becomes equal to E (or for $R \to \infty$)

5. If e.m.f decreases $\Rightarrow \dfrac{V}{\ell}$ decreases $\therefore$ position of zero deflection increases.

6. Otherwise resistance per unit length of Bridge wire be different over different length of meter Bridge.

7. N.C.E.R.T page 101

8. Milliammeter. To produce large deflection due to small current we need a large number of turns we need a large number of turns in armature coil $\therefore$ Resistance increases.

9. Temperature, Material Blue, Red, Orange Gold

10. The electron number density is of the order of 10^{29} m^{-3}. $\therefore$ the net current can be very high even if the drift spread is low.

11. $V = E + ir$

    $= 2 + 0.1\ 5$

    $= 2.5\ V$

12. Affects the uniformity of the cross-section area of wire and hence changes the potential drop across wire.

13. A potentiometer is said to be sensitive if :

    (i) It can measure very small potential differences.

    (ii) For a small change in potential diff. being measured it shows large change in balancing length.

3 MARKS ANSWERS

11. $R_1 = \dfrac{V_1}{I_1} = \dfrac{50}{2 \times 10^{-3}} = 25{,}000\Omega$

$$R_2 = \frac{V_2}{I_2} = \frac{60}{3 \times 10^{-3}} = 20{,}000\Omega$$

As Resistance changes with I, therefore conductor is non ohmic.

12. Rate of Production of heat, $P = I^2R$, for given I, P x R, $\therefore \rho_{nichrome} > \rho_{cu}$

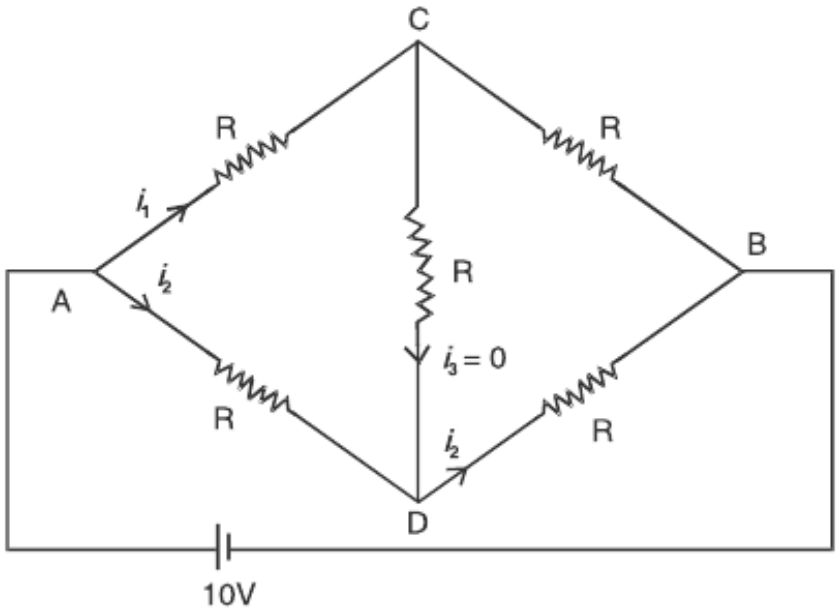
$\therefore R_{Nichrome} > R_{cu}$ of same length and area of cross section.

13. (i) If I in circuit is constant because $H = I^2 Rt$

(ii) If V in circuit is Constant because $H = \frac{V^2}{R} t$

17. $R_{AB} = 2\Omega$

$$I_{CD} = 0 \; I_{ACB} = \frac{V1}{2R2} = \frac{0}{\times 2} = 2.5A$$



18. (i) $\frac{E_2}{E_1} = \frac{I_2}{I_1} \Rightarrow E_2 \frac{I_2}{I_1} E_1 = \frac{80}{60} \times 1.5 = 2.0V$

(ii) The Circuit will not work if emf of driven Cell is IV, \ total Vottage across AB is IV, which cannot balance the voltage 1.5V.

(iii) No, since at balance point no current flows through galvanometer G, *i.e.,* cell remains in open circuit.

19. $E = I\,(R + r)$
$10 = 0.5\,(R + 3)$
$R = 17\Omega$
$V = E - Ir = 10 - 0.5 \times 3 = 8.5V$

20. Req = 7W

$$I_{4\Omega} = 1A,\ I_{1\Omega} = 2A,\ I_{12\Omega} = \frac{2}{3}A,\ I_{6\Omega} = \frac{4}{3}A,\ V_{AB} = 4V,\ V_{BC} = 2V,\ V_{CD} = 8V$$

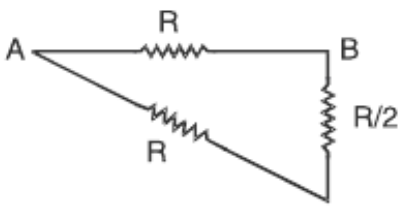
21. $$I = enAV_d = enA\frac{\ell}{t}$$

$$t = \frac{enA\ell}{I} = 2.7 \times 10^4 s$$

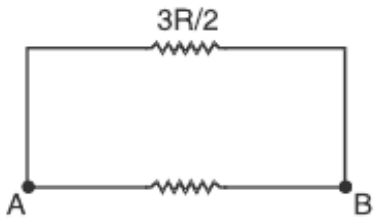
22. $$I = \frac{84}{\left(\frac{100 \times 400}{100 + 400} + 200\right)} = \frac{84}{280} = 0.3A$$

P.d across Voltmeter & 100Ω Combination

$$= 0.3 \times \frac{100 \times 400}{100 + 400} = 24V\ .$$



(i)



(ii)

Ans. : (i) $R_{AB} = \frac{3}{5}R$ (ii) $R_{AB} = 3/5\,R$