CURRENT ELECTRICITY

ELECTRIC CIRCUITS

SYNOPSIS

INTRODUCTION:

- Electric current is the flow of electric charges. Electric current is the result of motion of electrons or ions or holes under the influence of emf.
- Electric current is defined as rate of flow of electric charge. It is indicated by the letter 'i'.
  i = Q/t (or) i = ne/t, where 'e' is the electric charge on electron, n is the number of electrons.
- In S.I. system electric current is measured in ampere(A). It is basic unit in S.I. System.
- If one coulomb of charge (6.25×10^{18} electrons) passes across the cross section of a conductor every second, the current passing through the conductor is one ampere.
- In metals electrons are the charge carriers. In electrolytes the charge carriers are ions (Anions and Cations). In semiconductors electrons and holes are the charge carriers.
- Conventional direction of current is the direction opposite to the direction of electron motion. In a conductor conventional current flows from higher potential to lower potential but actually electrons flow from lower potential to higher potential.
- The device which converts chemical energy into electrical energy is called as 'CELL'.
- Cell is a source of EMF. It converts chemical energy into electrical energy.
- When connected between the ends of a conductor, a cell maintains constant potential difference between the ends of the conductor.

OHM'S LAW:

- Temperature remaining constant, the current flowing through a conductor is directly proportional to the potential difference across its ends. V = i R where R is resistance of the conductor and it is a constant at constant temperature.
- The resistance 'R' is measured in ohm (Ω). ohm is the resistance of that conductor which carries one ampere of current when the potential difference between its ends is one volt.

$$1\,ohm = \frac{1\,volt}{1\,ampere}$$

- All metals obey Ohm's law.
- The conductors which obey Ohm's law are called Ohmic conductors.
- For Ohmic conductors V – i graph is a straight line passing through origin (metals).
- The substances which do not obey Ohm's law are called non-Ohmic conductors.
  Ex: Thermistor, Electronic Valve, Semi-conductor devices etc.,
- The V – i graph for a non – Ohmic conductor is non-linear.

FACTORS EFFECTING THE RESISTANCE OF A CONDUCTOR:

- Resistance of a wire depends on nature of the material. Pure metals are good conductors.
- Impurities increases the resistance of a wire.
- Resistance of a wire depends on dimensions.
- The resistance of a conductor is directly proportional to length of the conductor and inversely proportional to area of cross section.

$$R \,\alpha\, l \quad and \quad R \,\alpha\, \frac{1}{A}, \quad \therefore R = S\frac{l}{A}$$

  where 'S' is known as specific resistance (or) resistivity.
- The specific resistance of the material of a conductor $S = \frac{RA}{l}$
- Unit of specific resistance is ohm–meter $(\Omega\, m)$.
- Specific resistance or resistivity of a material is the resistance between opposite faces of a unit cube of the material.
- The specific resistance does not change with the shape of the resistor. It depends only on the material of the conductor at constant temperature.
- Reciprocal of resistance is called electrical conductance. G = 1/R. Unit of conductance is siemen (or) mho.
- Reciprocal of specific resistance is called conductivity (σ). Its Unit is $\Omega^{-1}\, m^{-1}$ and seimen/meter.
- If 2 wires having lengths l_1, l_2 and areas of cross - section A_1 and A_2 respectively are made of same material, the ratio of their resistances.

$$\frac{R_1}{R_2} = \left(\frac{l_1}{l_2}\right)\left(\frac{A_2}{A_1}\right) = \left(\frac{l_1}{l_2}\right)\left(\frac{r_2^2}{r_1^2}\right)$$

- When both the wires are made of different materials.

$$\frac{R_1}{R_2} = \left(\frac{S_1}{S_2}\right)\left(\frac{l_1}{l_2}\right)\left(\frac{A_2}{A_1}\right) = \left(\frac{S_1}{S_2}\right)\left(\frac{l_1}{l_2}\right)\left(\frac{r_2^2}{r_1^2}\right)$$

where S_1 and S_2 are specific resistances of both the wires.

- If two wires made of same material have lengths l_1, l_2 and masses m_1 and m_2 respectively, then

$$\frac{R_1}{R_2} = \left(\frac{l_1^2}{l_2^2}\right)\left(\frac{m_2}{m_1}\right)$$

- If two wires made of same material have equal masses (or) when a wire is stretched from length l_1 *to* l_2, then

$$\frac{R_1}{R_2} = \left(\frac{l_1^2}{l_2^2}\right) = \left(\frac{A_2^2}{A_1^2}\right) = \left(\frac{r_2^4}{r_1^4}\right)$$

- If a wire of resistance R is stretched to 'n' times its original length, its resistance becomes n^2 R.
- If a wire of resistance R is stretched until its radius becomes $\frac{1}{n}$ th of its original radius then its resistance becomes n^4R.
- When a wire is stretched to increase its length by x% (where x is very small) its resistance increases by 2x %.
- When a wire is stretched to increase its length by x% (where x is large) its resistance increases by $\left(2x + \frac{x^2}{100}\right)$.
- When a wire is stretched to reduce its radius byx% (where x is very small), its resistance increases by 4x%.
- Resistance of a conductor varies with temperature.
- Variation of resistance in a metal wire with temperature is approximately given by $R_t = R_o(1 + \alpha t)$ (or)

$$\alpha = \frac{R_t - R_o}{R_o t} = \frac{R_2 - R_1}{R_1 t_2 - R_2 t_1}$$

where α is called temperature co-efficient of resistance. Unit for α is /ºC. (per degree Centigrade) or /K (per Kelvin).

- In metals resistance increases with temperature (α is +ve).
- For carbon, mica, thermistor, semi-conductors, electrolytes etc., the resistance decreases with increase of temperature. Hence 'α' for these materials is negative.
- The resistance of manganin is constant and does not change with temperature. Hence standard resistance coils are made up of manganin or constantan. (The value of α is nearly zero).
- Nichrome has high specific resistance and low 'α'. Hence it is used for making heating elements in electric heaters.
- Filament in an electric bulb is made of tungsten, which is having high melting point.
- Fuse wires are usually made of materials of high resistance and low melting point.
- If resistors of resistances R_1, R_2, R_3, ... are connected in series, the resultant resistance $R = R_1 + R_2 + R_3 + \ldots\ldots$
- When resistances are connected in series, same current passes through each resistor. But the potential differences are in the ratio $R_1 : R_2 : R_3 : \ldots$
- When resistors are joined in series, the effective resistance is greater than the greatest resistance in the circuit.
- If resistors of resistance R_1, R_2, R_3 ....are connected in parallel, the resultant resistance R is given by

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

- If resistances R_1 and R_2 are connected in parallel, the resultant resistance.

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

- When resistors are joined in parallel the potential difference across each resistor is same. But the currents are in the ratio $i_1 : i_2 : i_3 : \ldots\ldots\ldots\ldots$

$$= \frac{1}{R_1} : \frac{1}{R_2} : \frac{1}{R_3} : \ldots\ldots\ldots\ldots$$

- When resistors are joined in parallel, the effective resistance is less than the least resistance in the circuit.
- A wire of resistance 'R' is cut into 'n' equal parts and all of them are connected in parallel, equivalent resistance becomes $\frac{R}{n^2}$.

- In 'n' wires of equal resistances are given, the number of combinations that can be made to give different resistances is 2^{n-1}.
- If 'n' wire of unequal resistances are given, the number of combinations that can be made to give different resistances is 2^n(If n >2).
- If 'n' wires each of resistance 'r' are connected to form a closed polygon, equivalent resistance across any two adjacent corners is $R=\left(\frac{n-1}{n}\right)r$.
- 12 wires each of resistance 'r' are connected to form a cube. Effective resistance across

  a) Diagonally opposite corners $=\frac{5r}{6}$.

  b) face diagonal $=\frac{3r}{4}$.

  c) two adjacent corners $=\frac{7r}{12}$.
- If two wires of resistivities S_1 and S_2, lengths l_1 and l_2 are connected in series, the equivalent resistivity

  $$S=\frac{S_1l_1+S_2l_2}{l_1+l_2}.$$

  If $l_1=l_2$ then $S=\frac{S_1+S_2}{2}$.

  If $l_1=l_2$ then conductivity $\sigma=\frac{2\sigma_1\sigma_2}{\sigma_1+\sigma_2}$.
- If two wires of resistivities S_1 and S_2, Areas of cross section A_1 and A_2 are connected in parallel, the equivalent resistivity

  $$S=\frac{S_1S_2(A_1+A_2)}{S_1A_2+S_2A_1}.$$

  If $A_1 = A_2$ then $S=\frac{2S_1S_2}{S_1+S_2}$.

  and conductivity $\sigma=\frac{\sigma_1+\sigma_2}{2}$.

PRIMARY CELLS:

- Voltaic, Leclanche, Daniel and Dry cells are primary cells. They convert chemical energy into electrical energy. They can't be recharged. They supply small currents.

SECONDARY CELLS (OR) STORAGE CELLS:

- Electrical energy is first converted into chemical energy and then the stored chemical energy is converted into electrical energy due to these cells.
- These cells can be recharged.
- The internal resistance of a secondary cell is low where as the internal resistance of a primary cell is large.

EMF OF A CELL:

- The energy supplied by the battery to drive unit charge around the circuit is defined as electro motive force of the cell.
- EMF is also defined as the absolute potential difference between the terminals of a source when no energy is drawn from it. i.e., in the open circuit of the cell. It depends on the nature of electrolyte used in the cell.

INTERNAL RESISTANCE OF A CELL:

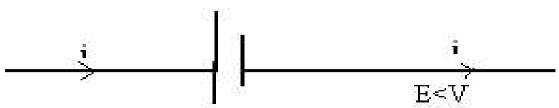
- It is the resistance offered by the electrolyte of the cell. It depends on
  - area of the electrodes used
  - distance between the electrodes
  - nature of electrolyte
  - area of cross section of the electrolyte through which the current flows and
  - age of the cell.
- Internal resistance of an ideal cell is zero.
- The power transferred to the load is maximum when external resistance becomes equal to the internal resistance by maximum power transfer theorem.
- When a cell of EMF 'E' and internal resistance 'r' is connected to an external resistance 'R' as shown, where i = current in the circuit

  V = potential difference across the external resistance

  V^1 = Voltage across internal resistance (or) lost volts

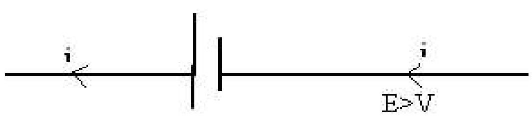
  Then,
  - EMF of the cell, $E = V + V^1$
  - From Ohm's law, $i=\frac{E}{(R+r)}=\frac{V+V'}{(R+r)}$
  - $V = iR = \frac{ER}{(R+r)}$
  - Fractional energy useful $=\frac{V}{E}=\frac{R}{R+r}$

- % of fractional useful energy = $\left(\frac{V}{E}\right)100 = \left(\frac{R}{R+r}\right)100$
- Fractional energy lost, $\frac{V'}{E} = \frac{r}{R+r}$
- % of lost energy, $\left(\frac{V'}{E}\right)100 = \left(\frac{r}{R+r}\right)100$
- internal resistance, $r = \left[\frac{E-V}{V}\right]R$
- When the cell is charging, the EMF is less than the terminal voltage (E < V) and the direction of current inside the cell is from + ve terminal to the –ve terminal.



$V = E + i\,r$

- When the cell is discharging, the EMF is greater than the terminal voltage (E >V) and the direction of current inside the cell is from – ve terminal to the +ve terminal.



$V = E - i\,r$

Hence $E \lessgtr V$

- If external resistance (R) is equal to the internal resistance (r) then the source delivers maximum power and the terminal voltage across the cell

$V = \frac{ER}{R+r} = \frac{E}{2}$

Hence the % of energy lost and energy useful are each equal to 50%

BACK EMF:

Due to the flow of current, the electrolyte decomposes into ions. These ions travel towards the opposite electrodes and produce EMF in the opposite direction of EMF that maintains the current. This opposing EMF is called back EMF and the phenomenon is called Electrolytic polarisation.

ELECTRIC CELLS IN SERIES:

When 'n' identical cells each of EMF 'E' and internal resistance 'r' are connected in series to an external resistance 'R', then

- total emf of the combination $= n\,E$
- effective internal resistance $= n\,r$
- Current through external resistance

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

- If $R << n\,r$ then $i = \frac{E}{r}$ = current from one cell
- If $R >> n\,r$ then $i = \frac{nE}{R}$
- By mistake if 'm' cells out of 'n' cells are wrongly connected to the external resistance 'R' then total emf decreases by the emf of '2m' cells and

(a) total emf of the combination = (n – 2m) E

(b) total internal resistance = n r

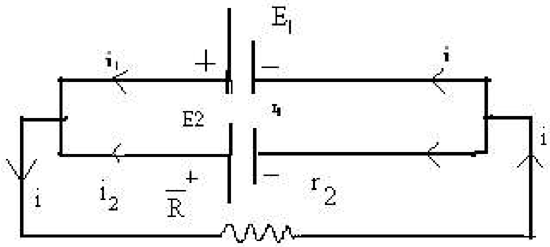
(c) total resistance = R + n r

(d) current through the circuit $(i) = \frac{(n-2m)E}{R+nr}$

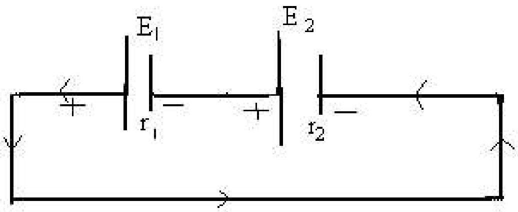
ELECTRIC CELLS IN PARALLEL:

When 'n' identical cells each of EMF 'E' and internal resistance 'r' are connected in parallel to an external resistance 'R', then

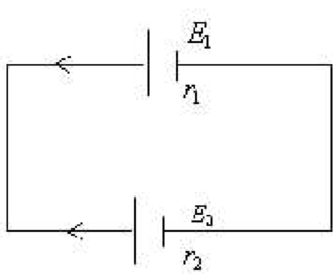
- total emf of the combination = E
- effective internal resistance $= \frac{r}{n}$
- total resistance in the circuit $= R + \frac{r}{n}$
- current through the external resistance = $\frac{E}{R+\frac{r}{n}} = \frac{nE}{nR+r}$
- If $R >> nr$, then $i = \frac{E}{R}$ = current from one cell.
- If $R << nr$, then $i = \frac{nE}{r}$
- If two cells of emf E_1 and E_2 having internal resistances r_1 and r_2 are connected in parallel to an external resistance 'R', then



- the effective emf, $E = \dfrac{E_1 r_2 + E_2 r_1}{r_1 + r_2}$
- the effective internal resistance, $= \dfrac{r_1 r_2}{r_1 + r_2}$
- Current through the circuit, $i = \dfrac{E}{r + R}$
- $i = i_1 + i_2$
- $i_1 = \dfrac{E_1 - iR}{r_1}$ and $i_2 = \dfrac{E_2 - iR}{r_2}$
- If two cells of emf E_1 and E_2 having internal resistances r_1 and r_2 are connected in series, then



- Current in the circuit, $(i) = \dfrac{E_1 + E_2}{r_1 + r_2}$
- The terminal voltages across the cells $V_1 = E_1 - ir_1$ and $V_2 = E_2 - ir_2$
- When two cells of emf E_1 and E_2 and internal resistances r_1 and r_2 are connected in parallel, then



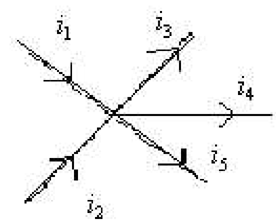
- Current in the circuit, $i = \dfrac{E_1 - E_2}{r_1 + r_2}$
- the terminal voltages across the cells, $V_1 = V_2$

  $V_1 = E_1 - i r_1$ and $V_2 = E_2 + i r_2$
- Electric Power (P) $= \dfrac{W}{t} = Ei = i^2 R = \dfrac{E^2}{R}$
- Work done by electric current $W = Pt = Eit = i^2 Rt = \dfrac{E^2 t}{R}$
- Heat energy produced due to the electric current $H = \dfrac{W}{J} = \dfrac{Pt}{J} = \dfrac{Eit}{J} = \dfrac{i^2 Rt}{J} = \dfrac{E^2 t}{RJ}$

  where J is mechanical equivalent of heat.

KIRCHHOFF'S LAWS:

FIRST LAW: The algebraic sum of electric currents meeting at a junction is zero.

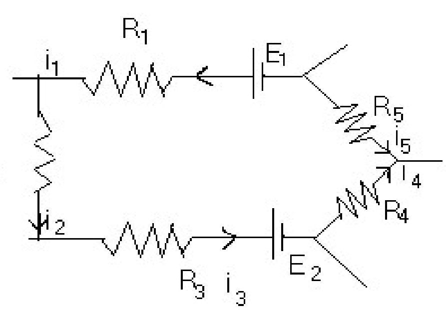


For the junction 'P'

$i_1 + i_2 - i_3 - i_4 - i_5 = 0$ (or)

$i_1 + i_2 = i_3 + i_4 + i_5$

SECOND LAW: The algebraic sum of emfs or potential differences around a closed circuit is zero.



For the closed circuit ABCDEA

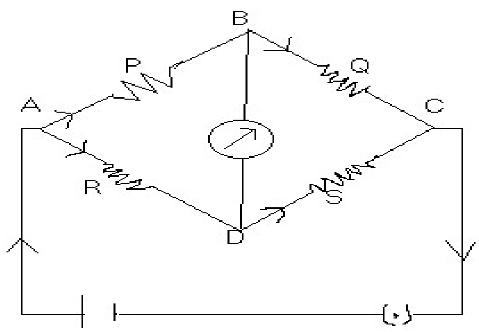
$$+E_1 - i_1 R_1 - i_2 R_2 - i_3 R_3 - E_2 - i_4 R_4 + i_5 R_5 = 0$$

SIGN CONVENTION IN KIRCHHOFF'S LAWS:

- While going from + ve of a battery to the negative through a cell, emf is negative.

- While going in the direction of the current through a conductor, potential difference is negative.
- Kirchhoff's first law is known as junction law or point law or Kirchhoff's current law and second law is known as loop theorem or Kirchhoff's voltage law.
- Kirchhoff's first law obeys law of conservation of electric charge. Kirchhoff's second law obeys law of conservation of energy.

WHEATSTONE BRIDGE:



- Wheatstone bridge is a circuit used to compare the ratio of nearly equal resistances. It consists of four arms, each consisting a resistor.
- If two of the resistors of the four are known, the other two can be compared. If three resistances are known the fourth one can be calculated.
- If the current through the galvanometer in a Wheatstone bridge is made zero, then the bridge is balanced.
- When the Wheatstone bridge is balanced, then

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

- Equivalent resistance of a balanced wheatstone network is $R_{eq} = \frac{(P+Q)(R+S)}{P+Q+R+S}$

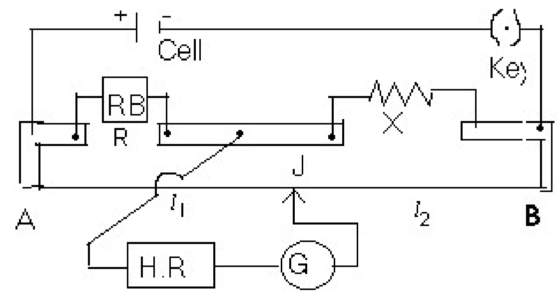
Meter bridge :

- It works on the principle of Wheatstone Bridge. It is the simplified form of Wheatstone Bridge.
- It is used to find unknown resistance of a wire, specific resistance of the wire and also used to compare resistances.
- When the Meter bridge is balanced then

$$\frac{R}{X} = \frac{l_1}{l_2} = \frac{l_1}{100 - l_1}$$

Where l_1 *is* the balancing length from the left end.

- A high resistance is connected in series to the galvanometer to protect it from higher currents.



POTENTIOMETER:

- It is a device which is used to
  a) Compare emfs of two cells
  b) determine the current in a circuit
  c) determine the internal resistance of a cell
  d) determine the unknown resistance.
  e) measure thermo emfs
- A cell of emf E and internal resistance r in the primary circuit maintains uniform potential gradient along the length of its wire.
  Current through the potentiometer wire, $i = \frac{E}{r+R}$.
- Potential gradient or potential drop per unit length $= \frac{iR}{l}$ where 'l' is the total length of potentiometer wire, 'R' is the total resistance of the wire and 'i' is the current through potentiometer wire due to primary circuit.
- If a resistance R_S is connected in series with the potentiometer wire then $i = \frac{E}{r+R+R_S}$ and

  potential drop per unit length $= \left(\frac{E}{r+R+R_S}\right)\frac{R}{l}$
- Comparison of emfs using potentiometer: If l_1 **&** l_2 *are* balancing lengths when two cells of emfs E_1 & E_2 are connected in the secondary circuit.

  one after the other then, $\frac{E_1}{E_2} = \frac{l_1}{l_2}$
- Internal resistance of a cell

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

Where l_1 = balancing length for the cell connected in the secondary circuit.

l_2 = balancing length when a resistance R is connected in parallel to the cell.

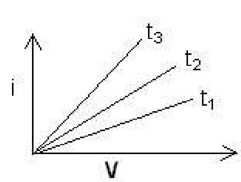
E = emf of the cell

V = Terminal voltage.

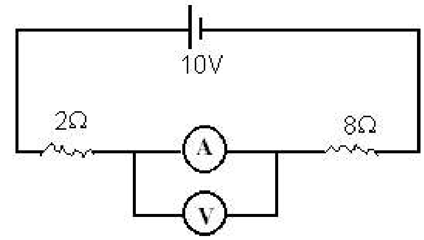
CONCEPTUAL QUESTIONS

OHM'S LAW

1. The flow of the electric current through a metallic conductor is
   1) Only due to electrons
   2) Only due to +ve charges
   3) Due to both nuclei and electrons.
   4) can not be predicted.
2. The resistance of a conductor is
   1) Inversely proportional to the length.
   2) Directly proportional to the square of the radius.
   3) Inversely proportional to the square of the radius.
   4) Directly proportional to the square root of the length.
3. S.I. unit of electrical conductivity
   1) siemen 2) siemen/metre
   3) siemen metre 4) ohm metre
4. For making standard resistance, wire of following material is used
   1) Nichrome 2) Copper
   3) Silver 4) manganin
5. Material used for heating coils is
   1) Nichrome 2)Copper
   3) Silver 4)Manganin
6. A piece of silver and another of silicon are heated from room temperature. The resistance of
   1) each of them increases
   2) each of them decreases
   3) Silver increases and Silicon decreases.
   4) Silver decreases and Silicon increases.
7. i-v graph for a metal at temperatures t_1, t_2, t_3 are as shown. The highest temperature is



   1) t_1 2) t_2 3) t_3 4) All are equal.
8. In the given electrical circuit A and V are ideal ammeter and voltmeter respectively. The voltmeter reading will be



   1) 10V 2) 2V 3)8V 4) zero
9. A silicon piece and a silver piece are connected in series and a potential difference is applied between their free ends. The pds on them are V_1 and V_2 respectively. They are then cooled to 200 K. Now.
   1) V_1 increases V_2 decreases
   2) Both increase
   3) Both decrease
   4) V_1 decreases V_2 increases
10. Choose the incorrect relation among the following
   1) Ampere = coulomb/second
   2) 1 volt = coulomb/joule
   3) Ohm = volt/ampere
   4) 1 coulomb = 6.25×10^{18} x electron charge.
11 The area of current – time graph gives
   1) Current 2) Charge
   3) Potential 4) Resistance
12. A certain piece of copper is to be shaped into a conductor of minimum resistance. Its length and cross sectional area should be
   1) L and A 2) 2L and A/2
   3) L/2 and 2A 3) 3L and A/3
13. When light falls on semiconductors, their resistance
   1) decreases 2) increases
   3) does not change 4) cann't be predicted
14. The resistance of an open circuit is
   1) Infinity 2) Zero
   3) Negative 4) cann't be predicted
15. The formula V = IR is applicable to
   1) Ohmic conductor only
   2) Non ohmic conductor only
   3) Both Ohmic & Non ohmic conductors
   4) Neither ohmic nor nonohmic conductor
16. With the increase of temperature, the ratio of conductivity to resistivity of a metal conductor
   1) Decreases 2) Remains same
   3) Increases 4) Many increase Hence
17. The conductivity of a super conductor, in the super conducting state is
   1) Zero 2) Infinity
   3) Dependson temp
   4) Depends on free election

18. Temperature coefficient of resistance 'α' and resistivity 'r' of a potentiometer wire must be
1) high and low 2) low and high
3) low and low 4) high and high

19. Back emf of a cell is due to
1) Electrolytic polarization
2) Pettier effect
3) Magnetic effect of current
4) All the above

20. The direction of current in a cell is
1) $(-)$ ve pole to $(+)$ ve pole during discharging
2) $(+)$ ve pole to $(-)$ ve pole during discharging
3) Always $(-)$ ve pole to $(+)$ ve pole
4) Both 1 & 2

21. When an electric cell drives current through load resistance, its Back emf,
1) Supports the original emf
2) Opposes the original emf
3) Supports if internal resistance is lo
4) Opposes if load resistance is large

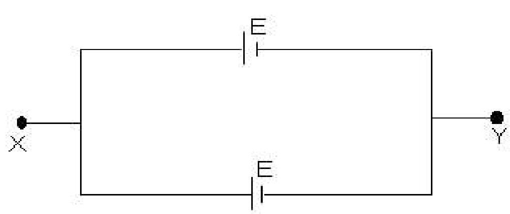
INTERNAL RESISTANCE - EMF

22. Choose the correct statement
1) The difference of potential between the terminals of a cell in closed circuit is called emf of the cell.
2) electromotive force and accelerating forcehave the same dimensions.
3) The internal resistance of an ideal cell is infinity.
4) The difference between the emf of a cell and potential difference across the ends of the cell is called 'lost volts'.

23. The terminal voltage of a cell is greater than its e.m.f. when it is
1) being charged 2) an open circuit
3) being discharged 4) it never happens

24. Which of the following is a standard cell
1) Daniel cell 2) Cadmium cell
3) Leclanche cell 4) Lead accumulator

25. Two cells each of e.m.f.2V and internal resistance 1 ohm are connected as shown. The p.d. between X and Y



1) 4V 2) 2V 3) 1V 4) zero

26. 'n' identical cells, each of internal resistance (r) are first connected in parallel and then connected in series across a resistance (R). If the current through R is the same in both cases.
1) R = r/2 2) r = R/2 3) R = r 4) r = 0

KIRCHHOFF'S LAWS - WHEATSTONE BRIDGE

27. Kirchoff's law of meshes is in accordance with law of conservation of
1) charge 2) current
3) energy 4) angular momentum

28. Kirchoff's law of junctions is also called the law of conservation of
1) energy 2) charge
3) momentum 4) angular momentum

29. Wheatstones's bridge can not be used for measurement of very ———— resistances.
1) high 2) low
3) low(or) high 4) zero

METERBRIDGE

30. A metre bridge is balanced with known resistance in the right gap and a metal wire in the left gap. If the metal wire is heated the balance point.
1) shifts towards left 2) shifts towards right
3) does not change
4) may shift towards left or right depending on the nature of the metal.

31. In metre bridge experiment of resistances, the known and unknown resistances are interchanged . The error so removed is
1) end correction 2) index error
3) due to temperature effect
4) random error

32. In a metre-bridge experiment, when the resistances in the gaps are interchanged, the balance-point did not shift at all. The ratio of resistances must be
1) Very large 2) Very small
3) Equal to unity 4) zero

POTENTIOMETER

33. A potentiometer is superior to voltmeter for measuring a potential because
1) voltmeter has high resistance
2) resistance of potentiometer wire is quite low
3) potentiometer does not draw any current from the unknown source of e.m.f. to be measured.
4) sensitivity of potentiometer is higher than that of a voltmeter.

34. In comparing e.m.f.s of 2 cells with the help of potentiometer, at the balance point, the current flowing through the wire is taken from
1) Any one of these cells.
2) both of these cells
3) Battery in the main circuit
4) From an unknown source.

35. The radius of potentiometer wire is doubled without changing its length. The value of potential gradient.
1) increases 4 times 2) increases two times
3) Does not change 4) becomes half

36. In a potentiometer of ten wires, the balance point is obtained on the sixth wire. To shift the balance point to eighth wire, we should
1) increase resistance in the primary circuit.
2) decrease resistance in the primary circuit.
3) decrease resistance in series with the cell whose e.m.f. has to be measured.
4) increase resistance in series with the cell whose e.m.f. has to be measured.

37. If the emf of the cell in the primary circuit is doubled, with out charging the cell in the secondary circuit, the balancing length is
1) Doubled 2) Halved
3) Uncharged 4) Zero

38. The potential gradients on the potentiometer wire are V_1 and V_2 with an ideal cell and a real cell of same emf in the primary circuit then
1) $V_1 = V_2$ 2) $V_1 > V_2$
3) $V_1 < V_2$ 4) None

39. If the current in the primary circuit is decreased, then balancing length is obtained at
1) Lower length 2) Higher length
3) Same length 4) None of the above

KEY

1. 1	2. 3	3.2	4.4	5.1
6. 3	7. 1	8.4	9.1	10.2
11.2	12.3	13.1	14.1	15.3
16.2	17.2	18.2	19.1	20.4
21.2	22.4	23.1	24.2	25.4
26.3	27.3	28.2	29.2	30.2
31.1	32.3	33.3	34.3	35.3
36.1	37.2	38.2	39.2	

NUMERICAL QUESTIONS
LEVEL - I
ELECTRIC CURRENT

1. The current passing through a conductor is 5 ampere. The charge that passes through that conductor in 5 minute is
1) 1200 C 2) 300 C 3) 1000 C 4) 1500 C

2. The current through a conductor is 1 ampere. The no. of electrons that pass through the conductor in one second is
1) 3.125×10^{18} 2) 6×10^{18}
3) 6.25×10^{18} 4) 12.5×10^{18}

3. If the electron in a Hydrogen atom makes 6.25×10^{15} revolutions in one second, the current is
1) 1.12 mA 2) 1 mA 3) 1.25 mA 4) 1.5 mA

4. If 240 coulomb of charge passes through a cross section of a conductor in 4 minute, the average current is
1) 1A 2) 1.6A 3) 1.8 A 4) 2 A

5. 1 μ A current represents how many electrons/s crossing a section conductor through which it passes is
1) 6.25×10^{12} 2) 12.5×10^{6}
3) 3.125×10^{12} 4) 3.125×10^{6}

OHM'S LAW

6. A current of 4 ampere is passing through a conductor which is having a potential difference of 10 V . Its conductance is
1) 0.4 s 2) 2.5 s 3) 40 s 4) 4 s1

7. An electric bulb works on 230 V line and draws 0.1 A current. The resistance of the filament is
1) 230 Ω 2) 2300 Ω 3) 23 Ω 4) 2.3 Ω

8. A potential difference of 110 V exists across the terminals of an electric motor whose effective resistance is equal to 5.5 ohm. The current drawn by it is
1) 200A 2) 2A 3) 20A 4) 605 A

9. The resistance of a wire of length 100 cm and 7×10^{-3} cm radius is 6 ohm. Its specific resistance is
1) $924 \times 10^{-8}\ \Omega$ cm 2) $92.4 \times 10^{-8}\ \Omega$ m
3) $900 \times 10^{-8}\ \Omega$ cm 4) $224 \times 10^{-8}\ \Omega$ m

10. A metallic wire of resistance 20 ohm stretched until its length is doubled. Its resistance is
1) 20 Ω 2) 40 Ω 3) 80 Ω 4) 60 Ω

11. The lengths of two wires made of same material are 2m and 1m. Their radii are 1mm and 2mm. The ratio of their specific resistances is
1) 2 : 1 2) 1 : 2 3) 4 : 1 4) 1 : 1

12. The least resistance that one can have from six resistors of each 0.1 ohm resistance is
1) 0.167 Ω 2) 0.00167 Ω
3) 1.67 Ω 4) 0.0167 Ω

13. The resistance of a wire of 100 cm length is 10 Ω. Now, it is cut into 10 equal parts and all of them are twisted to form a single bundle. Its resistance is
1) 1 Ω 2) 0.5 Ω 3) 5 Ω 4) 0.1 Ω

14. The resistance of a wire is 10 ohm. The resistance of a wire whose length is twice and the radius is half, if it is made of same material is
1) 20 Ω 2) 5 Ω 3) 80 Ω 4) 40 Ω

15. The ratio of lengths of two wires made up of same material is 2 : 3 and the ratio of areas of cross section 3 : 2 . The ratio of their resistances is
1) 9 : 4 2) 4 : 9 3) 1 : 3 4) 3 : 1

16. Using three wires of resistances 1 ohm, 2ohm and 3 ohm, how many different resistance values are possible?
1) 6 2) 4 3) 10 4) 8

17. Using three identical resistors how many different values of resistances are possible?
1) 8 2) 6 3) 4 4) 3

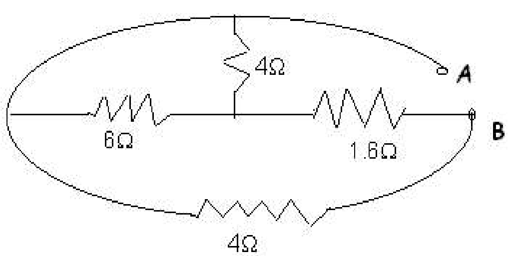
18. A wire of resistance 20 Ω is bent in the form of a square. The resistance between the ends of diagonal is
1) 10 Ω 2) 5 Ω 3) 20 Ω 4) 15 Ω

19. A one kilogram roll of copper wire has a resistance of 2 ohm. The resistance of 4kg roll of copper wire of half the thickness of the wire to the first roll is
1) 128 Ω 2) 32 Ω 3) 16 Ω 4) 4 Ω

20. Two wires made of same material have their electrical resistances in the ratio 1 : 4. If their lengths are in the ratio 1 : 2, the ratio of their masses is
1) 1: 1 2) 1 : 8 3) 8 : 1 4) 2 : 1

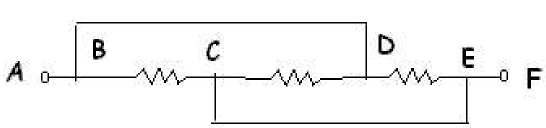
21. A letter 'A' is constructed of a uniform wire of resistance 1 ohm/cm. The sides of the letter are 20 cm long and the cross piece in the middle is 10cm long while the vertex angle is 60^0. The resistance of the letter between the two ends of the legs is
1) 40/3 Ω 2) 80/3 Ω 3) 40 Ω 4) 10 Ω

22. If four resistances are connected as shown in the fig. between A and B the effective resistance is



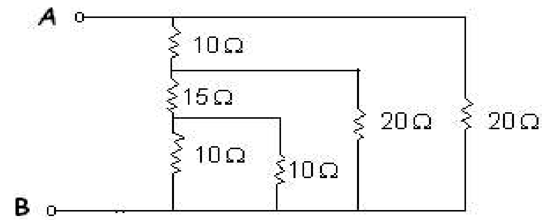
1) 4 Ω 2) 8 Ω 3) 2.4 Ω 4) 2 Ω

23. Three resistances each of 3 Ω are connected as shown in fig. The resultant resistance between A and F is



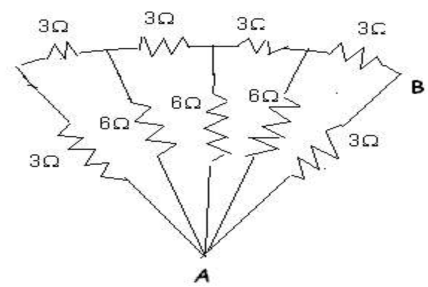
1) 9 Ω 2) 2 Ω 3) 4 Ω 4) 1 Ω

24. The effective resistance between A and B is



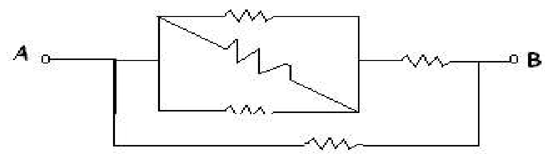
1) 10 Ω 2) 20 Ω 3) 30 Ω 4) 20.2 Ω

25. The resistance between A and B is



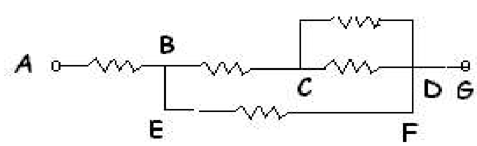
1) 9 Ω 2) 2 Ω 3) 12 Ω 4) 8 Ω

26. Each resistance shown in the fig. aside is 7 ohm. The reslutant resistant resistance between A and B is



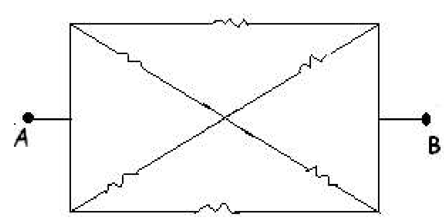
1) 4 Ω 2) 6 Ω 3) 9.33 Ω 4) 12 Ω

27. Resistance of each 10 Ω are connected as shown in the fig. The effective resistance betweeen A and G is



1) 16 Ω 2) 20 Ω 3) 12 Ω 4) 8 Ω

28. Six resistances of each 12 ohm are connected as shown in the fig. The effective resistance between the terminals A and B is



1) 8 Ω 2) 6 Ω 3) 4 Ω 4) 12 Ω