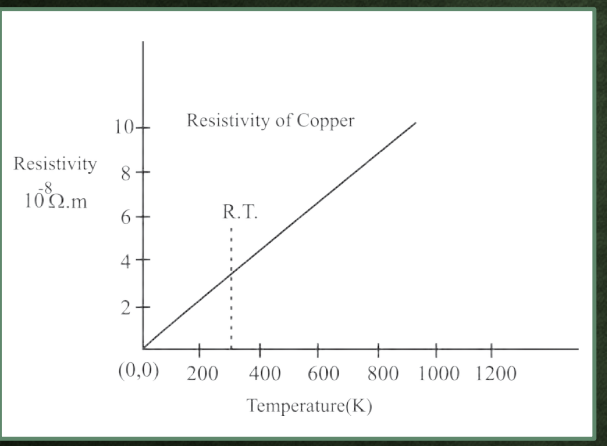
ELECTRIC CURRENT THROUGH CONDUCTOR

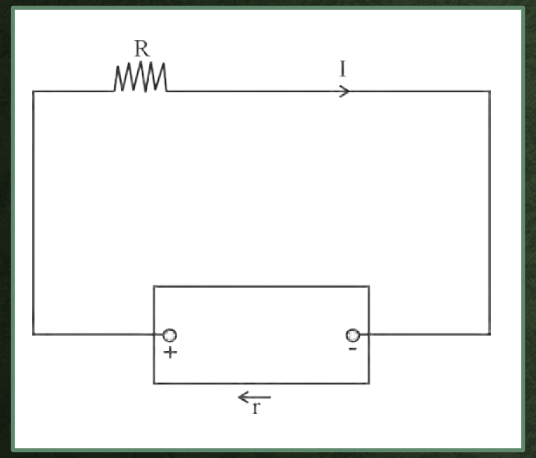
Chap-11

VARIATION OF RESISTANCE WITH TEMPERATURE



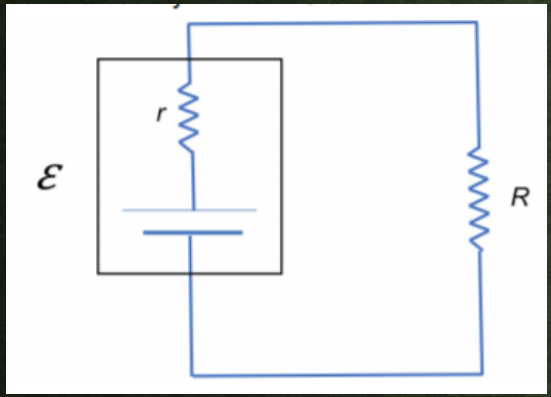
- Resistivity of A MATERIAl VARIES with TEMPERATURE
- Fig. shows the VARIATIOn of resistivity of copper AS A function of temPERATURE (K)
- It CAN be seen THAT the VARIATION is LINEAR over A CERTAIN RANGE of temPERATURES
- Such A LINEAR RELATION CAN be expressed AS, $\rho = \rho_0[1+ \alpha(T - T_0)]$
- where T is the chosen reference tempERATURE AND ρ in the resistivity AT the chosen TEMPERATURE

ELECTROMOTIVE FORCE (EMF)



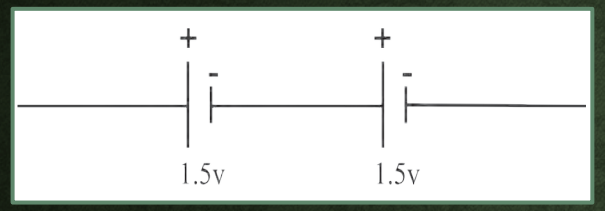
- When CHARges flow through A CONDUCTOR, A POTENTIAL difference HAS to be ESTABLISHED between the two ends of the conductor
- For A STEADY flow of CHARges, this POTENTIAL difference is required to be MAINTAINED ACROSS the two ends of the conductor, the terminALS
- There is A device THAT does so by doing work on the CHARges, thereby MAINTAINING the POTENTIAL difference is called battery.
- The work done or energy spent per unit charge by battery to complete one round of close circuit is called electromotive force (EMF) denoted by E
- Example of source of EMF, Power cells, BATTERIES,SOLAR cells, fuel cells, AND even GENERATORS ETC.
- Fig. shows A CIRCUit with AN emf (E) device with internal resistane r AND A resistor *R* .
- Here, the emf device keeps the positive TERMINAL (+) AT A higher electric POTENTIAL THAN the NEGATIVE TERMINAL (-).
- Now suppose THAT A CHARge *dq* flows through the cross section of conductor of the circuit in time dt
- The device must do work *dw* on the CHARge *dq*, to flow from path of circuit and to maintain this flow, device must have to be doing the work.
- Thus we define the emf of the emf device E =
- The SI unit of emf is joule/coulomb(J/C) or volt (V)

CURRENT PASSING THROUGH CLOSE CIRCUIT



- In A REAL emf device, there is AN INTERNAL RESISTANCE to the motion of CHARge CARRIERS
- If such A device is not connected in A CIRCUIT, there is no current through it and the emf is EQUAL to the POTENTIAL difference ACROSS the two termiNALS of the emf device.
- If A current (*I*) flows through AN emf device, there is AN INTERNAL RESISTANCE (*r*) AND the emf (E) differs from the POTENTIAL difference ACROSS its two TERMINALS (*V*) i.e. *V*= E- (*I*) (*r*) ----------(I)
- The NEGATIVE sign is due to the FACT THAT the current *I* flows through the emf device from the NEGATIVE TERMINAL to the positive TERMINAL
- By the APPLICATION of Ohm's LAW, V=IR
- HENCE, IR = E- (*I*) (*r*)
- I R + I *r* = E => I =
- Thus, the MAXIMUM current THAT CAN be DRAWN from the emf device is when *R* = 0, i.e.

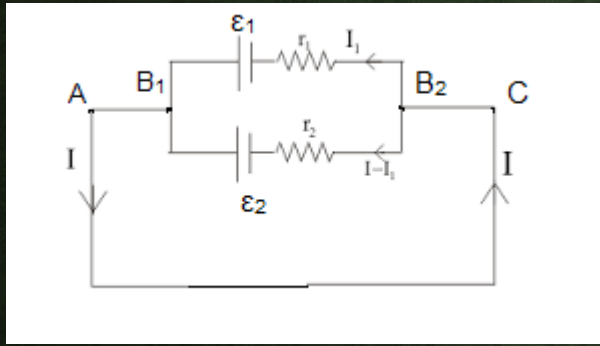
CELLS IN SERIES



- In A SERIES COMBINATION, cells ARE connected in single ELECTRICAL PATH, such THAT the positive TERMINAL of one cell is connected to the NEGATIVE TERMINAL of the next cell, AND so on
- The TERMINAL VOLTAGE of BATTERY/CELL is EQUAL to the sum of VOLTAGES of INDIVIDUAL cells in series
- The EQUIVALENT emf of n number of cells in series COMBINATION is the ALGEBRAIC sum of their INDIVIDUAL emf
- The EQUIVALENT INTERNAL RESISTANCE of n cells in A SERIES COMBINATION is the sum of their INDIVIDUAL INTERNAL RESISTANCE
- HENCE, TERMINAL POTENTIAL DIFFERENCE, V = - I
- ADVANTAGES of cells in series:

1) The cells connected in series produce A LARger RESULTANT VOLTAGE
2) Cells which ARE DAMAGED CAN be EASILY identified, hence CAN be EASILY REPLACED

CELLS IN PARALLEL



- In parallel combination, positive TERMINALS of ALL the cells ARE connected together AND the NEGATIVE TERMINALS of ALL the cells ARE connected together
- In PARALLEL connection, the current is divided AMONG the BRANCHES i.e. AND AS SHOWN in fig
- Consider points AND HAVING POTENTIALS AND , respectively
- Hence, potential difference across terminal is V = -

  for cell , V = - => =

  for cell V= - => =
- But *I* = + = +

  I = - + - = + - V

  V = + - I

  V = - *I*

  = - I

  =

  where = and = i.e. = and =
- For *n* number of cells connected in PARALLEL, = -------+ and = ---------+

ADVANTAGE AND DISADVANTAGE OF PARALLEL COMBINATION

- **ADVANTAGES of cells in PARALLEL :** For cells connected in PARALLEL in A CIRCUIT, the circuit will not BREAK open even if A CELL gets DAMAGED or open
- **DISADVANTAGES of cells in PARALLEL :** The VOLTAGE developed by the cells in PARALLEL connection CANNOT be INCREASED by INCREASING number of cells present in circuit

TYPES OF CELLS

- **Primary cell:** A PRIMARY cell CANNOT be CHARged AGAIN. It CAN be used only once.
- E.g. Dry cells, ALKALINE cells etc.
- **Secondary cell:** The SECONDARY cell ARE RECHARGEABLE AND CAN be reused.
- The CHEMICAL REACTION in A SECONDARY cells is reversible
- E.g. LEAD ACID cell, AND fuel cell
- **Fuel cells vehicles (FCVs):** Fuel cells vehicles (FCVs) ARE electric vehicles THAT use fuel cells INSTEAD of LEAD ACID BATTERIES to power the vehicles
- Hydrogen is used AS A fuel in fuel cells
- The by- product AFTER its burning is WATER
- This is IMPORTANT in terms of reducing emission of greenhouse GASES produced by TRADITIONAL GASOLINE fueled vehicles
- The hydrogen fuel cell vehicles ARE thus more environment friendly