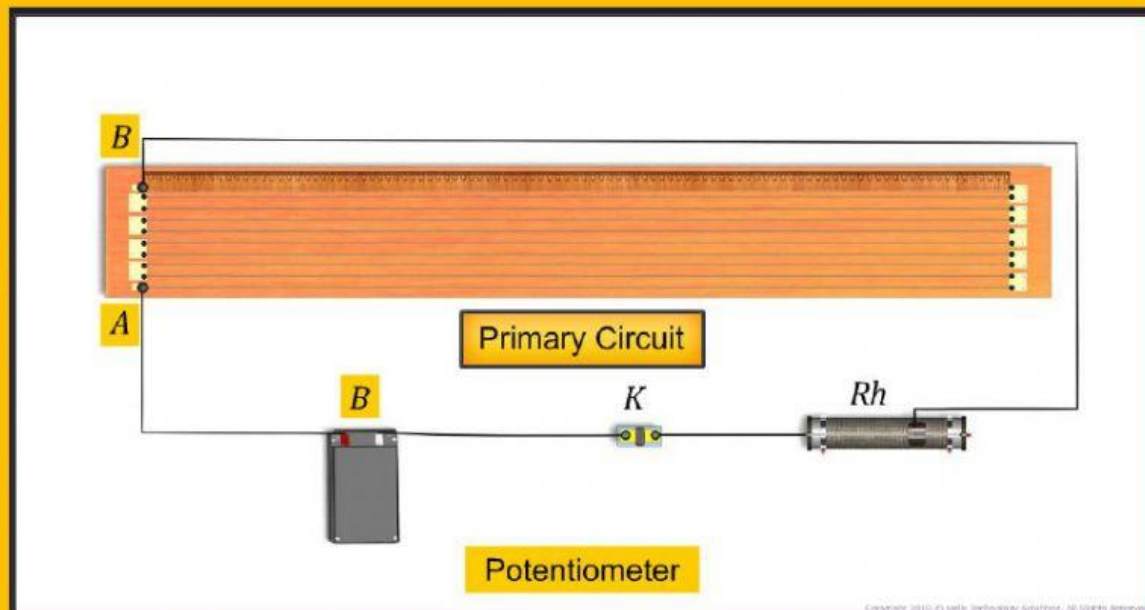
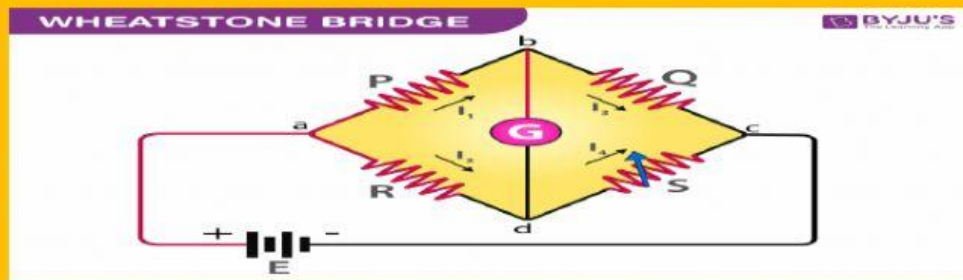
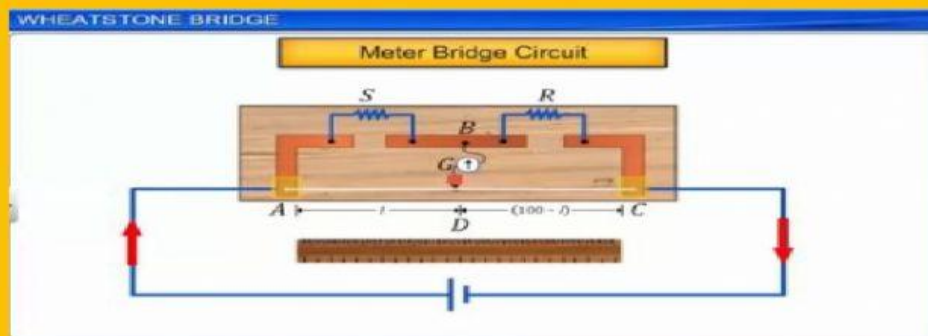




MASTER CARD ON CURRENT ELECTRICITY

Ohm's Law

- $V = IR$
- Vector form, $\vec{J} = \sigma \vec{E}$, conductivity $\sigma = \frac{1}{\rho}$
- Resistance of a uniform conductor, $R = \frac{\rho l}{A}$
- Conductance, $G = \frac{1}{R}$
- Resistivity or specific resistance, $\rho = \frac{RA}{l}$
Ohm's law is not valid for semiconductor.

Drift Speed

- Drift speed, $v_d = \frac{eE}{m}$
- Mobility, $\mu_e = \frac{v_d}{E} = \frac{e\tau}{m}$
- Mobility of electron is more than that of hole.
- Current in terms of drift velocity,
 $I = neAv_d = \frac{ne^2 A \tau E}{m} = neA\mu_e E = neA\mu_e \frac{V}{l}$
- $\sigma = ne\mu_e$
- In terms of relaxation time τ ,
 $R = \frac{ml}{ne^2 \tau A}$ and $\rho = \frac{m}{ne^2 \tau}$

Resistors

- Resistance of a resistor with colour code
 $R = (\text{digit 1})(\text{digit 2})(\text{Decimal Multiplier} \pm \text{Tolerance})$
- Variation of resistance with temperature,
 $R_T = R_0[1 + \alpha(T - T_0)]$
Temperature coefficient of resistance, $\alpha = \frac{R_2 - R_1}{R_1(T_2 - T_1)}$
If $T_1 = 0^\circ\text{C}$ and $T_2 = T^\circ\text{C}$, then
 $\alpha = \frac{R_T - R_0}{R_0 \times T}$ or $R_T = R_0(1 + \alpha T)$
- Resistivity of conductor increases with increase in temperature.
- Resistivity of semiconductor decreases with increase in temperature.

Combination of Resistors

- In series, equivalent resistance
 $R_S = R_1 + R_2 + R_3 + \dots$
- In parallel, equivalent resistance
 $\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$
- For two resistances in parallel current through the two resistances, $I_1 = \frac{R_2 I}{R_1 + R_2}$, $I_2 = \frac{R_1 I}{R_1 + R_2}$
- When resistances are connected in series, the current through each resistance is same. In parallel combination voltage is same.

Potentiometer

- Principle: Fall of potential across any portion of the wire, $V \propto i$, $V = K l$
Here, $K = \frac{V}{l}$ = potential gradient.
- Comparison of emfs of two cells,
 $\frac{E_1}{E_2} = \frac{l_1}{l_2}$
- Internal resistance of a cell
 $r = R \left(\frac{V}{V_0} - 1 \right) = R \left(\frac{l_2}{l_1} - 1 \right)$
Here, l_1 = balancing length of potentiometer wire corresponding to emf of the cell.
 l_2 = balancing length of potentiometer wire corresponding to potential difference of the cell when a resistance R is connected in series with the cell whose internal resistance to be determined.

Electric Current

- Rate of flow of electric charge (positive)
 $I = \frac{dQ}{dt} = \oint \vec{J} \cdot d\vec{S}$
- $\vec{J}$ is the current density which is the current passing through a cross-section of the wire.
- Dot product of $\vec{J}$ and $d\vec{S}$ shows current is scalar inspite of this we represent current with an arrow.
- In case of an electron revolving in a circle of radius r with speed v , period of revolution of electron is $T = \frac{2\pi r}{v}$.
- Frequency of revolution $\omega = \frac{v}{2\pi r}$
- Current in an orbit of a moving electron with velocity v , $I = \frac{e v}{T} = \frac{e v}{2\pi r}$

Flow of Charge

- $\Delta Q = i \Delta t$ (Current is constant)
 $= \int i dt$ (Current is a function of time)
= Area under $I-t$ graph

Kirchhoff's Rules

- Junction Rule:** At any junction of circuit elements, the sum of currents entering the junction must be equal to the sum of currents leaving it.
 $\Sigma I = 0$.
It is based on conservation of charge.
So bending or reorienting the wire does not change the validity of Kirchhoff's junction rule.
- Loop Rule:** The algebraic sum of changes in potential around any closed loop must be zero.
 $\Sigma e = \Sigma IR$
It is based on conservation of energy.

Sign Convention for Kirchhoff's Rules

- While traversing a closed loop (clockwise or anti clockwise) if negative pole of the cell is encountered first, then its emf is negative, otherwise positive.
- The product of resistance and current in an arm of the circuit is taken positive if the direction of current in that arm is in the same sense as one moves in a closed path and is taken negative if the direction of current in that arm is opposite to the sense as one moves in a closed path.
- This convention depends on your choice. You can go to reverse of this assumption and will get same answer.

Wheatstone Bridge

- In balanced condition,
 $\frac{R_1}{R_2} = \frac{R_3}{R_4}$
- It provides a parallel method to determine the value of an unknown resistance.

Meter Bridge

- Resistance of unknown resistor,
 $R = \frac{S l_1}{(100 - l_1)}$
- It is more sensitive if l_1 (balance point) is close to 50 cm. This requires a suitable choice of S .

Electrical Energy and Power

- Heat energy developed across a resistor
 $H = I^2 R t$
- Power $P = I^2 R = \frac{V^2}{R}$
- For transmission cable, power loss
 $P_C = I^2 R_C = \frac{P^2 R_C}{V_C^2}$, $P = \text{constant}$

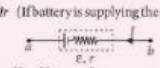
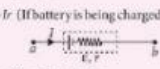
Principle of Bulb

- Resistance of bulb
 $R = \frac{V^2}{P}$ or $R \propto \frac{1}{P}$
- In parallel $P = P_1 + P_2$
- In series $\frac{1}{P} = \frac{1}{P_1} + \frac{1}{P_2}$ or $P = \frac{P_1 P_2}{P_1 + P_2}$
- In $R = \frac{V^2}{P}$ V and P are rated values for that bulb.
- In parallel a bulb having more rated power glows more brightly. In series a bulb having less rated power glows more brightly.

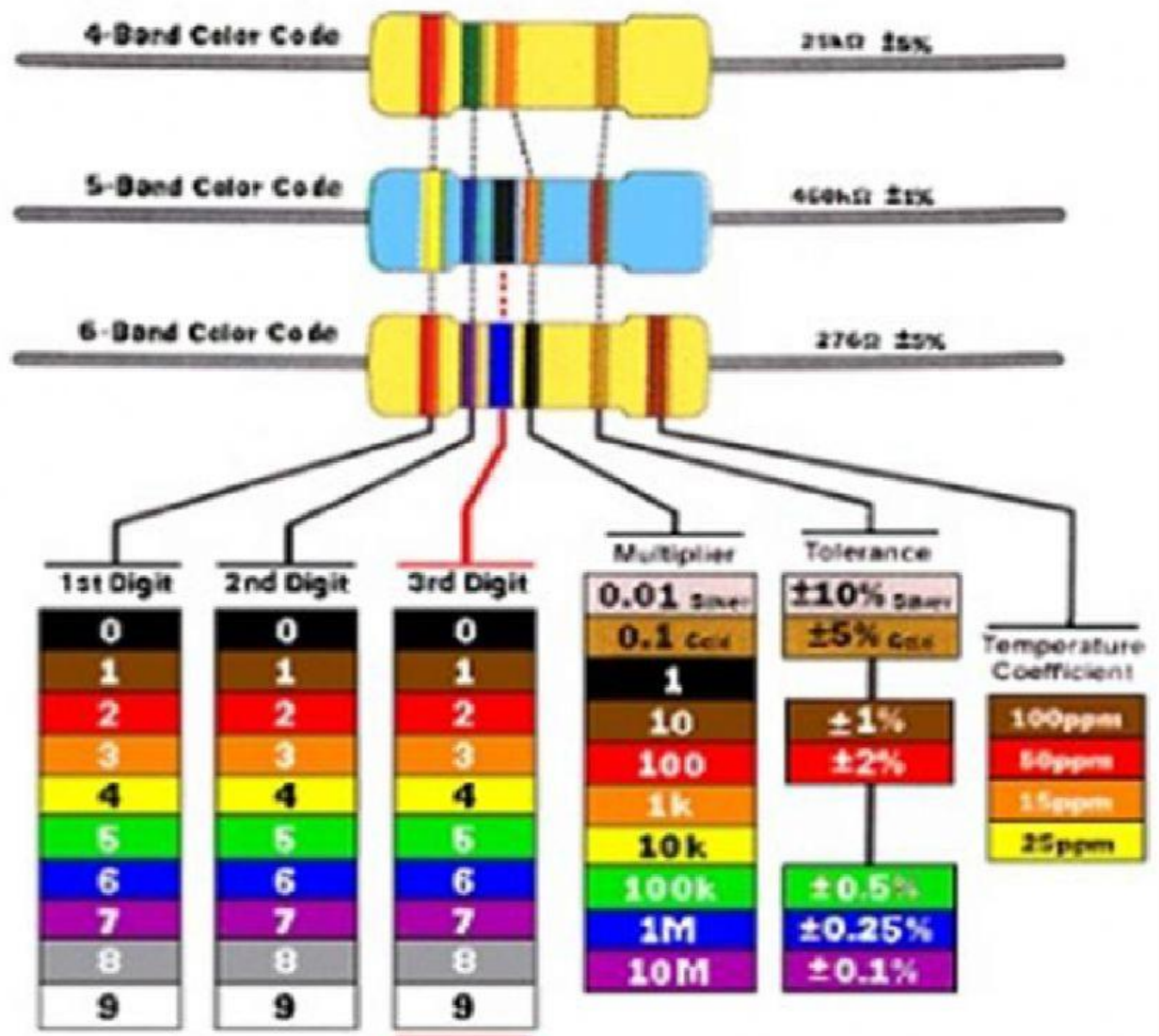
Grouping of Batteries

- Series grouping: $I = \frac{\text{net emf}}{\text{net resistance}}$
If there are n identical batteries of emf ϵ and internal resistance r , then current through external resistance R (if all batteries are additive in nature) is given by
 $I = \frac{n\epsilon}{nr + R}$
If polarity of m batteries is reversed, then
 $I = \frac{(n-2m)\epsilon}{nr + R}$
- Parallel grouping with identical batteries:
 $I = \frac{n\epsilon}{r_{\text{net}}}$
Here, $\epsilon_{\text{net}} = \epsilon$, $R_{\text{net}} = \text{Total internal resistance} + \text{Total external resistance} = r + R$
- Parallel grouping with unidentical batteries:
 $I = \frac{n\epsilon_{\text{net}}}{R_{\text{net}}}$
Here, $\epsilon_{\text{net}} = \frac{\Sigma(\epsilon/r)}{\Sigma(1/r)}$... (i)
If any of the battery is oppositely connected, then place negative sign in numerator of eqn. (i) but, no change in denominator.
- Mixed grouping:
If there are n rows of identical batteries (ϵ, r) with m cells in each row. Then, $I = \frac{n\epsilon_{\text{net}}}{R_{\text{net}}}$
Here, $\epsilon_{\text{net}} = m\epsilon$, $R_{\text{net}} = \frac{mr}{n} + R$
In this case current through the external resistance is maximum when, $g = \frac{mr}{n}$

Potential Difference across the Terminals of a Battery

- $V = \epsilon$ (If $I = 0$)
- $V = 0$ (If battery is short circuited)
- $V = \epsilon - Ir$ (If battery is supplying the energy)

- $V = \epsilon + Ir$ (If battery is being charged)


COLOUR CODDING



FLOW CHART

CURRENT ELECTRICITY

