# Physics
# Theory Part 8

Topics: Electronics/ Electromagnetic Theory

Course: B.Sc/ Physics

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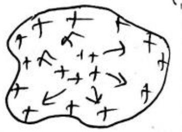
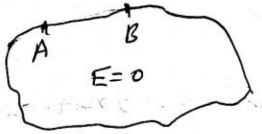
# Electrostatics for a Conducting body & Gauss's Law

(a) Free charges on a solid conductor resides entirely on its surface for a electrostatic case. This may be interpreted in terms of coulomb's repulsion among all the same sign charges, this causes them to move as far as possible in a conductor so at the outer surface of the conductor. So charges moves to the edges of the conductor, to minimise its electrostatic potential.



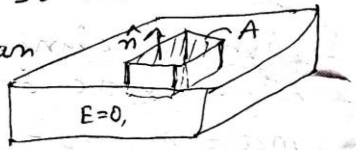
(b) Inside a conductor electric field E is always zero.




Now $E = -\nabla V = 0 \Rightarrow V = \text{Const} \Rightarrow V_A = V_B$

So inside of a conductor is an equipotential. If this does not happen then charges will start flowing from higher potential to lower, causing a current to flow in a conductor without any source, which is not possible as it is a static case.

(c) Draw a matchbox Gaussian surface that slightly penetrates the surface; lateral sides are small, so no flux passing through them.




Top side has Area A and contributes to flux

By Gauss's law $\oint \vec{E} \cdot \vec{ds} = \frac{q}{\epsilon_0}$

or, $E \times A = \frac{\sigma A}{\epsilon_0}$ ; $E = \frac{\sigma}{\epsilon_0}$

& $\boxed{\vec{E} = \frac{\sigma}{\epsilon_0} \hat{n}}$ so Electric field through lateral surface is independent of its area or distance.

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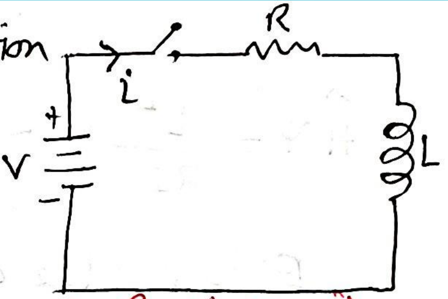
(a) current flows in clockwise direction because current is coming out of the terminal in the given L-R ckt, find the Transient current, i.



L-R Circuit

(b) Maximum current, $I_{max} = \frac{V}{R}$.

(c) Applying Kirchhoff's voltage law $V - iR - L\frac{di}{dt} = 0$

or, $\int_0^t \frac{dt}{L} = \int_0^i \frac{di}{V - iR}$ or, $\frac{t}{L} = \int_0^i \frac{di}{V - iR}$

let $z = V - iR \therefore \frac{dz}{di} = -R$ at $i = 0, z = V \mid z = V - iR$

$$\frac{t}{L} = -\frac{1}{R}\int \frac{dz}{z} = -\frac{\ln z}{R}\Big|_V^{V-iR} = -\frac{1}{R}\ln\frac{V - iR}{V}$$

or, $e^{-Rt/L} = \frac{V - iR}{V}$ or, $i = \frac{V}{R}\left(1 - e^{-Rt/L}\right)$ $\tau = R/L = T.C$

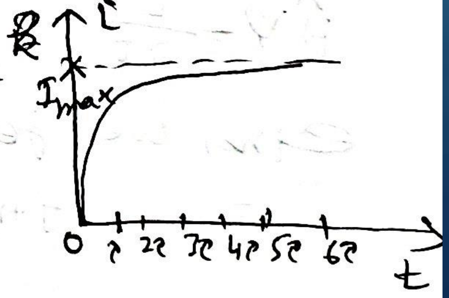
$I_{max} = V/R$

$$\boxed{i = I_{max}\left(1 - e^{-\tau t}\right)}$$

(d) when $t \to \infty$, $i = I_{max} \therefore V_R = I_{max}R$

(e) when $t \to \infty$, $i = I_{max} = \text{Const}$

$$V_L = L\frac{di}{dt} = L\frac{dI_{max}}{dt} = 0.$$



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**Thanksss**