Topic: 5. Electricity & Magnetism

Formulae

$I = \frac{\Delta q}{\Delta t}$

$P = IV$ consumed by component

$P = I^2R$ Dissipation

$P = V^2/R$

$E = \frac{V}{d}$ Parallel Plates E-Field strength N.D.B.

d = distance
V = P.D.
V is different at distances.
E is same in the whole area between plates.

Series: $I = CONST$, $R = R_1 + R_2 + R_3$

Parallel: $V = CONST$, $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

$V_{OUT} = \frac{V_{IN} \times R_2}{R_1 + R_2}$ Potential Divider

N.D.B. $B = \frac{\mu_0 I}{2\pi d}$ Magnetic field strength at d from a current-carrying wire. μ = permeability

$B = \frac{\mu_0 I}{2R}$ Magnetic field strength in center of a current-carrying loop of radius R. N.D.B.

$F = \frac{kq_1q_2}{r^2}$ Coulomb's Law (Spherical only)

$k = 8.99 \times 10^9 Nm^2C^{-2}$

Kirchoff's Laws: $\Sigma V = 0$ (Loop) $\Sigma I = 0$ (junction)

Moving charge in a B-field: $F = qvB\sin\theta$

Force on length L wire due to B-field: $F = BIL\sin\theta$

$k = \frac{1}{4\pi\varepsilon_0}$

$I = nAvq$ A = cross-section, n = number density

$R \propto \rho\frac{L}{A}$

$R \propto T$

$\Delta V = \frac{\Delta E_p}{q}$ NDB P.D & PE

$E = Vq$ Energy converted from chem to electrical NDB

$C = \frac{1}{\sqrt{\varepsilon_0 \mu_0}}$

$V = \frac{W}{q} = \frac{kQ}{r}$

$E = \frac{F}{q} = \frac{kQ}{r^2}$ Electric field strength

$V = IR$ Only for resistor

$\varepsilon = I(R+r)$ EMF of cell

Required Definitions

Current I – the time rate Δt at which charge Δq moves past a point in a circuit. (A)

Electric field strength E – the force per unit charge acting on a ~~charge~~ point due to ~~another~~ a charge.

Potential difference V – Work done per unit charge in moving a point charge to another point.

Drift Velocity v – Average velocity that an electron attains due to an electric field.

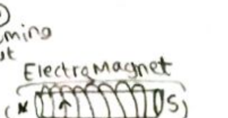
Resistance R – Voltage per unit current in a circuit or device. (Ω)

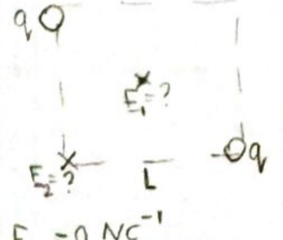
Power – rate at which work is done. (W)

Potential difference – work done in moving a (+) charge q from a point of lower potential energy to a point of higher potential energy.

Electromotive Force – chemical energy converted into electrical energy per unit charge.

Common Diagrams

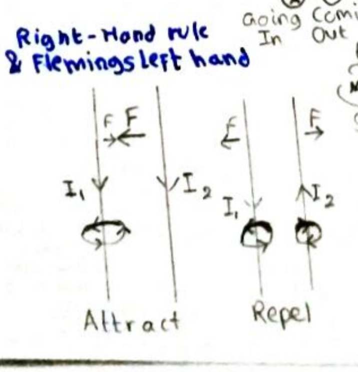




$E_1 = 0\ NC^{-1}$

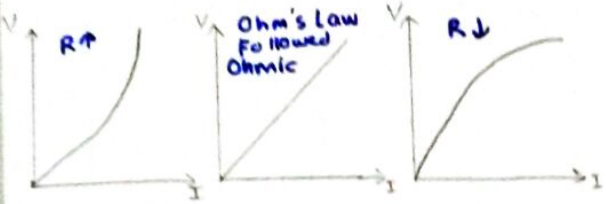
$E_2 = \sqrt{\left(\frac{kq}{L^2}\right)^2 + \left(\frac{kq}{L^2}\right)^2}$

Pythagoras



Topic 5 Electricity and Magnetism

Common Graphs



Experiment Summaries

Electroscope

You place a charge on the ball. Since each leaf has some charge left, they repel. Can't tell if + or − charge.

Other Notes / Learned From Past Papers

- Elementary charge = 1.6×10^{-19} C , 1 eV = 1.6×10^{-19} J
- Charge can neither be created nor destroyed. Charge is conserved.
- The cell pushes an electron out of the (−) side. This electron pushes the next because they repel. Hence, electomotive force is transferred to all charges in circuit.
- Inside a charge, the electric field strength and force is constant. Not zero. Then, it gets smaller or less negative.
- Work is independent of path since electric force is conservative.
- $E = \frac{V}{d}$ in parallel plates. Electric field is always from higher V to lower V.
- Ammeter is low resistance. Voltmeter is high resistance.
- Electrons feel a higher repulsive force at (−) terminal, so they move from (−) to (+). But, conventional current is (+) to (−).
- Magnetism arises when one charge moves in the vicinity of another charge.
- Strength of electromagnet is affected by: 1) No. of loops 2) Current 3) Material of core 4) Shape & size of core.
- A charge (moving) produces a B-field. Hence, it feels a force when in an external B-field.