

**Electrons**

$E = -1.6 \times 10^{-19}$  coulombs (C)

$E = 9 \times 10^9 \times 10^{-19}$  N/C

$E$  in N/C =  $9 \times 10^9$  N/C

$F_e = \frac{kQ_1 Q_2}{r^2} = qE$

$F_e$  = Force between the 2 objects

$K$  = constant =  $9 \times 10^9 \frac{\text{N} \cdot \text{m}^2}{\text{C}^2}$

$Q_1, Q_2$  = charge of object 1 & 2 (C)

$\text{Surface Area of sphere} = 4\pi r^2$

**Electric Field Strength**  
Force per coulomb exerted on a test charge at that point

$E = \frac{F_e}{q} = \frac{kQ}{r^2} = \frac{F_e}{r}$  also  $E = V/m = \frac{V}{r}$

$F_e = qE$

$E$  = electric field strength (N/C) (NC<sup>-1</sup> V/m<sup>-1</sup>)

In the same direction as  $F_e$ , if  $Q$  is positive

**Electric Potential near point charge  $Q$**

$V_1 = \frac{kQ}{r_1}$     $V_2 = \frac{kQ}{r_2}$

Potential  $V$  of surface of a sphere:  $V = \frac{kQ}{r}$

**ELECTRIC POTENTIAL DIFFERENCE**  
(Work (Joules) needed to move charge between 2 points)

$\Delta V = \frac{w}{q} = \frac{\text{Joules}}{\text{Coulomb}} = \frac{Nm}{C} = V_2 - V_1 = \frac{qEd}{2}$

INHENCE  $\frac{V}{m} = \frac{N}{C}$

**ENERGY METHOD**:  $W = qV = qEd = \frac{1}{2}mv^2$

$v = \sqrt{\frac{2qV}{m}}$

**INDUCTION**

$E = -1.6 \times 10^{-19}$  coulombs (C)

$E = 9 \times 10^9 \times 10^{-19}$  N/C

$E$  in N/C =  $9 \times 10^9$  N/C

$F_e = \frac{kQ_1 Q_2}{r^2} = qE$

**Coulomb Law**

**Parallel oppositely charged plates UNIFORM**

$E(V \text{ new } ) = \frac{V \text{ new }}{d \text{ new }} = \frac{V}{\frac{d}{2}} = \frac{2V}{d} = \frac{2Q}{d^2}$

$V = Ed = \frac{w}{q}$     $w = qEd$

$F_e = \frac{kQ_1 Q_2}{r^2} = qE$

**FORCE METHOD**:  $w = \frac{F_e}{q} = \frac{qEd}{2}$

$w^2 = w^2 + 2ws$     $w = \sqrt{s}$     $s = w^2 = \frac{w^2}{4}$

$w = \sqrt{2ws} = \sqrt{\frac{2qEds}{q}} = \sqrt{\frac{2V^2 s}{d}}$

**RESISTANCE LAW** (in ohms per meter)

$R_s = E/q = V/d = \frac{V}{q}$

$q = \frac{V}{R_s}$

**ELECTRON GUN**

$q_e \times V = \frac{mv^2}{2} \Rightarrow v = \sqrt{\frac{2 \times q_e \times V}{m}}$

$I = \frac{V}{R_s} = \frac{q}{V} = \frac{mv}{q}$

$V = IR_s = \frac{W}{q} = \text{work}/q = \text{EDRF}$

$R_s = \frac{V}{I} = \frac{W}{q} = \frac{W}{q} = \frac{I}{q} = \frac{IR_s}{q} = \pm \sqrt{Wq} = \frac{\sqrt{Wq}}{q} = \text{EDRF}$

$W = qV = \frac{V^2}{R_s} = I^2 R_s = Pt = IVt = \frac{1}{2}mv^2$

**Ohm's Law**

**RESISTIVITY** =  $\frac{\text{Resistivity}}{\text{Conductivity}} \approx 10^{-8} \Omega \cdot \text{m}$

**RESISTANCE**

$R_s \leq R_{\text{sh}}$

$R_s \times R_{\text{sh}} = R_{\text{sh}} \times R_{\text{sh}}$

$I_{\text{sh}} = I_s + I_{\text{sh}}$

$R_{\text{sh}} = \frac{I_s \times R_{\text{sh}}}{I_{\text{sh}} - I_s}$

**RESISTANCE**

$R_s = \text{series resistor (INCHIPS)}$

$I' = I_s \times (R_s + R_{\text{sh}})$

**Parallel oppositely charged plates UNIFORM**

$E(V \text{ new } ) = \frac{V \text{ new }}{d \text{ new }} = \frac{V}{\frac{d}{2}} = \frac{2V}{d} = \frac{2Q}{d^2}$

$V = Ed = \frac{w}{q}$     $w = qEd$

$F_e = \frac{kQ_1 Q_2}{r^2} = qE$

**FORCE METHOD**:  $w = \frac{F_e}{q} = \frac{qEd}{2}$

$w^2 = w^2 + 2ws$     $w = \sqrt{s}$     $s = w^2 = \frac{w^2}{4}$

$w = \sqrt{2ws} = \sqrt{\frac{2qEds}{q}} = \sqrt{\frac{2V^2 s}{d}}$

**RESISTORS IN SERIES**

$R_T = R_1 + R_2 + R_3 + R_4 \dots$

**RESISTORS IN PARALLEL**

$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$

**Energy Law**

$V = V_1 + V_2 + V_3 = \Phi$

$V = V_1 + V_2 + V_3$

**Convergent Resistance = Thicker resistance**

**POWER (Watts) Rate of energy transfer**

$P = \frac{\text{Energy (Joule)}}{t} = \frac{qV}{t} = IV = \frac{V^2}{R} = I^2 R$

$R_s = \frac{V^2}{I^2} = \frac{qV^2}{qI^2} = \frac{V^2}{P} = \frac{V^2 t}{W} = \frac{W}{t} = \frac{Vt}{q} = \frac{V}{I}$

$I = \frac{V}{R} = \frac{W}{qV} = \frac{q}{t} = \frac{C}{t} = \pm \sqrt{\frac{P}{R}} \Leftrightarrow \sqrt{\frac{qV}{tR}} = \frac{V}{R}$

$V = \frac{P}{I} = \frac{W}{q} = \frac{W}{q} = \frac{I}{q} = \frac{P}{q} = \pm \sqrt{Wq} = \frac{\sqrt{Wq}}{q} = \text{EDRF}$

$W = qV = \frac{V^2 t}{R} = I^2 R t = Pt = IVt = \frac{1}{2}mv^2$

**EDRF** =  $\frac{\text{Power}}{\text{Conductivity}} \approx 10^{-8} \Omega \cdot \text{m}$

**RESISTANCE**

$R_s \leq R_{\text{sh}}$

$R_s \times R_{\text{sh}} = R_{\text{sh}} \times R_{\text{sh}}$

$I_{\text{sh}} = I_s + I_{\text{sh}}$

$R_{\text{sh}} = \frac{I_s \times R_{\text{sh}}}{I_{\text{sh}} - I_s}$

**RESISTANCE**

$R_s = \text{series resistor (INCHIPS)}$

$I' = I_s \times (R_s + R_{\text{sh}})$

**CURRENT CARRYING WIRE IN A MAGNETIC FIELD**

$I$

$B$

$\theta$

$F = BIL \sin \theta$

$F = BIL \sin 90^\circ$

$F = BIL$

**ELECTROMAGNETIC INDUCTION**

$E = B \frac{dA}{dt} \rightarrow \text{CONVENTIONAL CURRENT goes to mag}$

**junction Law**

$I_1 = I_2 + I_3$

**RESISTORS IN PARALLEL**

$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$

**Energy Law**

$V = V_1 + V_2 + V_3 = \Phi$

$V = V_1 + V_2 + V_3$

**Convergent Resistance = Thicker resistance**

# Study Guide Physics Electronics

**Kenneth G. Nichols**

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