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ELECTROSTATICS

Study of rest Charge

Charge :→ It is the basic property of a particles due to which it produces or experience Electric and magnetic effect.

S.I Unit :- Coulomb →

C.G.S Unit → Electrostatic unit → e.s.u

$$1C = 3 \times 10^9 \text{ esu}$$ ✓

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$$1C \rightarrow \begin{bmatrix} 1\mu c \rightarrow 10^{-6} C \\ 1nc \rightarrow 10^{-9} C \\ 1pc \rightarrow 10^{-12} C \\ 1m \rightarrow 10^{-3} C \end{bmatrix}$$

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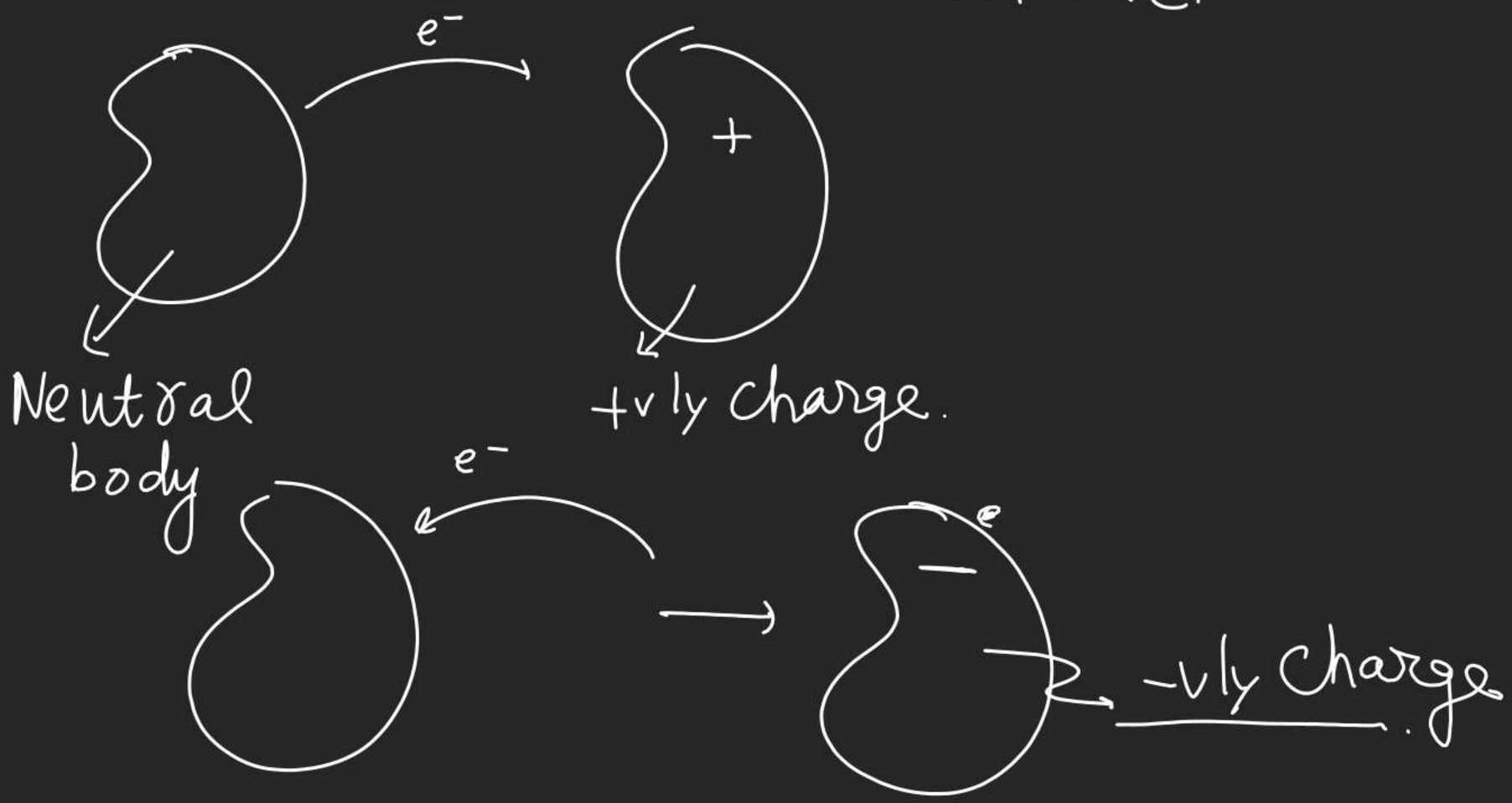
Properties of Charge

→ It exist in two form → +ve, -ve.



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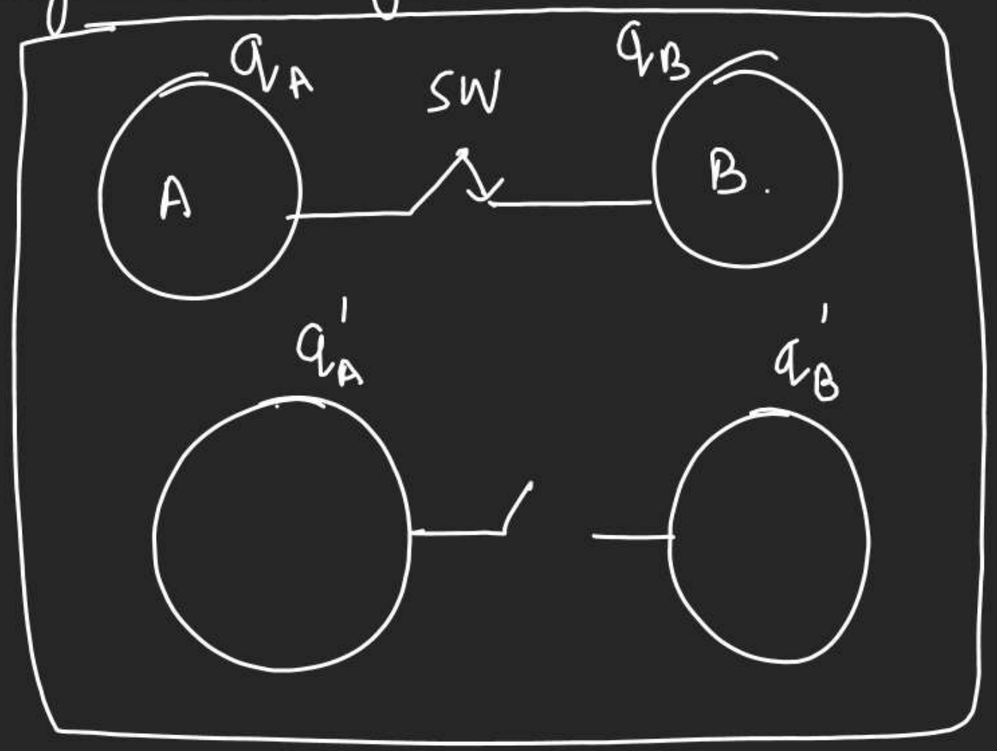
Charge always Conserved for an isolated System



$$q_A + q_B = q'_A + q'_B$$

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→ Charge is always quantized :-

↳ Charge on any body is integral multiple of fundamental charge ie charge of an electron or proton

$$Q = \pm ne$$

$n \in I^+$

$1e^- = -1.6 \times 10^{-19} C$

$1p \rightarrow +1.6 \times 10^{-19} C$

(★) Charge always associated with mass.

(★) Charge of a body doesn't depend on the velocity of body or not on the frame of refrance from which it is seen.

but mass is frame dependent

$$m = \frac{m_0}{\sqrt{1 - v^2/c^2}}$$

$n \in I^+$

↳ 1, 2, 3, 4

$v \rightarrow$ speed of mass

$c \rightarrow$ speed of light.

$C \rightarrow 3 \times 10^8$ m/s

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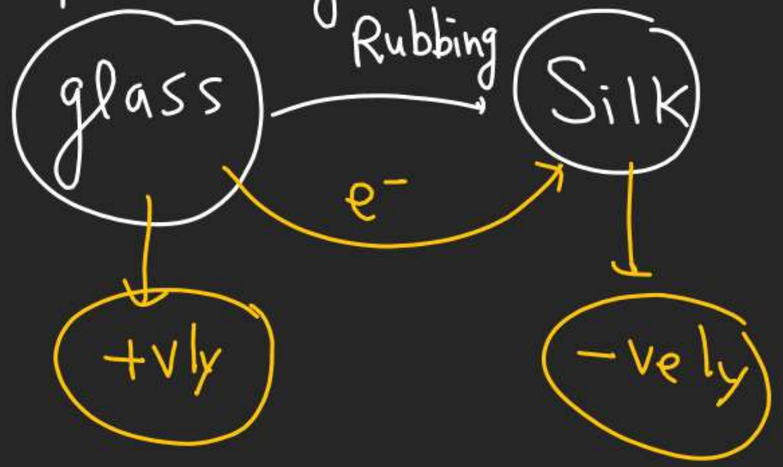
→ How Charge has been produced.

Friction

↳ Actual transfer of Charge.



Induction ✓

↳ It is redistribution of charge in a body Under the influence of some external charge or field.

∴

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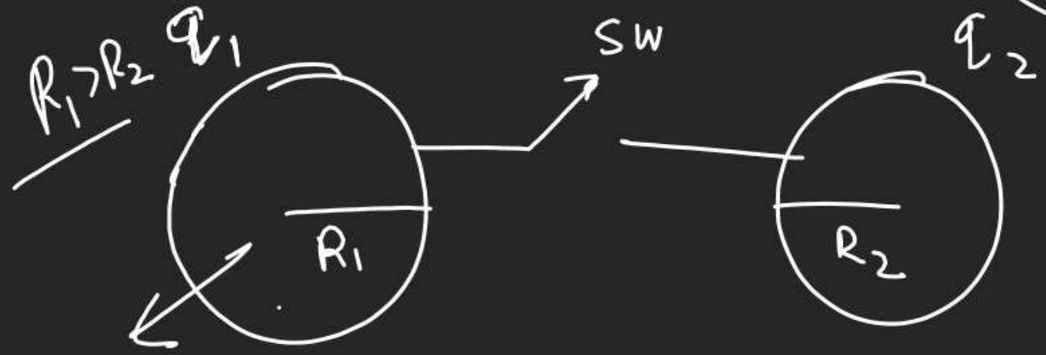
Conduction :-

Potential $\rightarrow V = \frac{Kq}{r}$



$\Rightarrow$ Charge transfer takes place from higher potential to lower potential

q_1' $= q_2'$

$$q_1 + q_2 = q_1' + q_2' \quad (2)$$

$$q_1 + q_2 = \left(\frac{R_2}{R_1} + 1\right) q_2'$$

$$\checkmark \quad q_2' = \frac{R_1 (q_1 + q_2)}{R_1 + R_2}$$

$$\checkmark \quad q_1' = \frac{R_2 (q_1 + q_2)}{R_1 + R_2}$$

$$\frac{q_1'}{q_2'} = \frac{R_2}{R_1} \quad (1) \quad (*)$$

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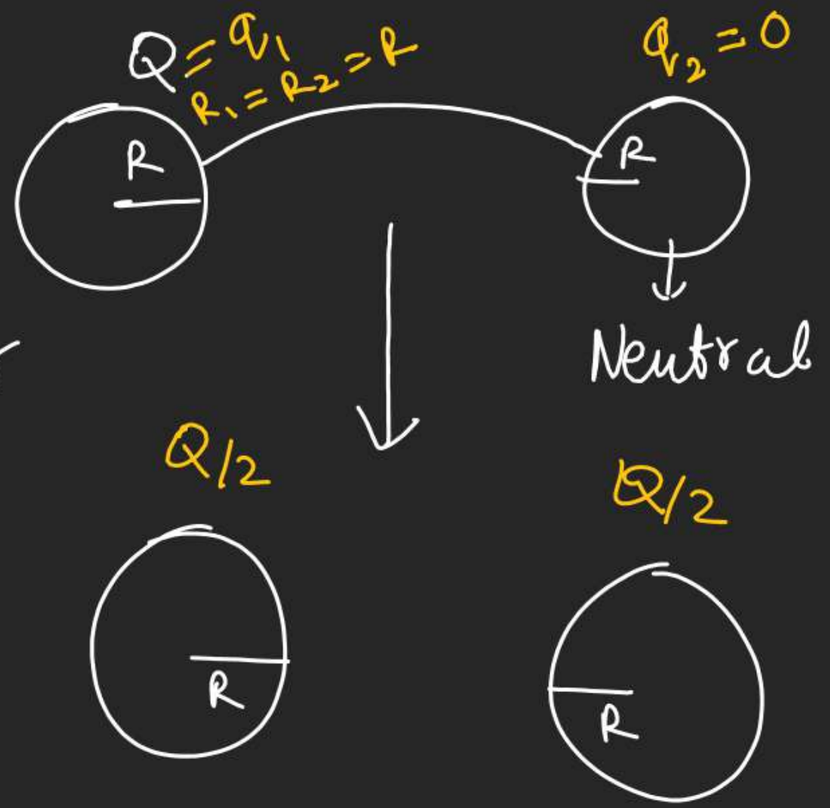
#



$$q_1' = \frac{R_2(q_1+q_2)}{R_1+R_2} = \frac{Q}{2}$$

($q_1 \to Q$, $q_2 \to 0$)

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($q_1 \to Q$, $q_2 \to 0$)

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ELECTROSTATICS

Influence of Charg around its Surrounding

→ Rest Charge

(+q) → Rest charge have influence around its surrounding called Electric field.

→ (+q) → V = C

↳ It has two influence
- → Electric field
- → Magnetic field

Field

It is influence of Certain things around its Surrounding

(+m) → Gravitational field.

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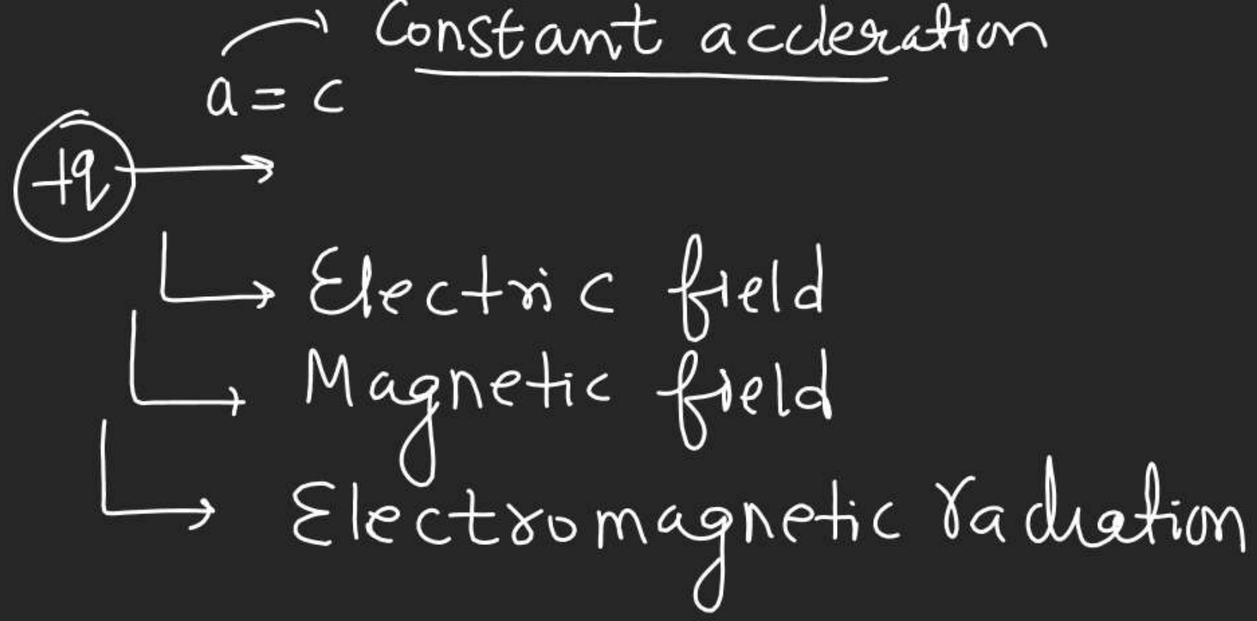
(A)



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ELECTROSTATICS

→ Coulomb's Law :-

↳ According to Coulomb;-

The Electrostatic force of interaction b/w two Charge particle is → (i) directly proportional to product of the magnitud of the charges.

(ii) Inversly proportional to Squar of the distance b/w them.

$$|F_{1/2}| = |F_{2/1}| \propto \frac{|q_1||q_2|}{r^2}$$

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$$|F_{1/2}| = |F_{2/1}| = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$$

$\varepsilon_0 \rightarrow$ [Permittivity in free Space or Vaccum.]

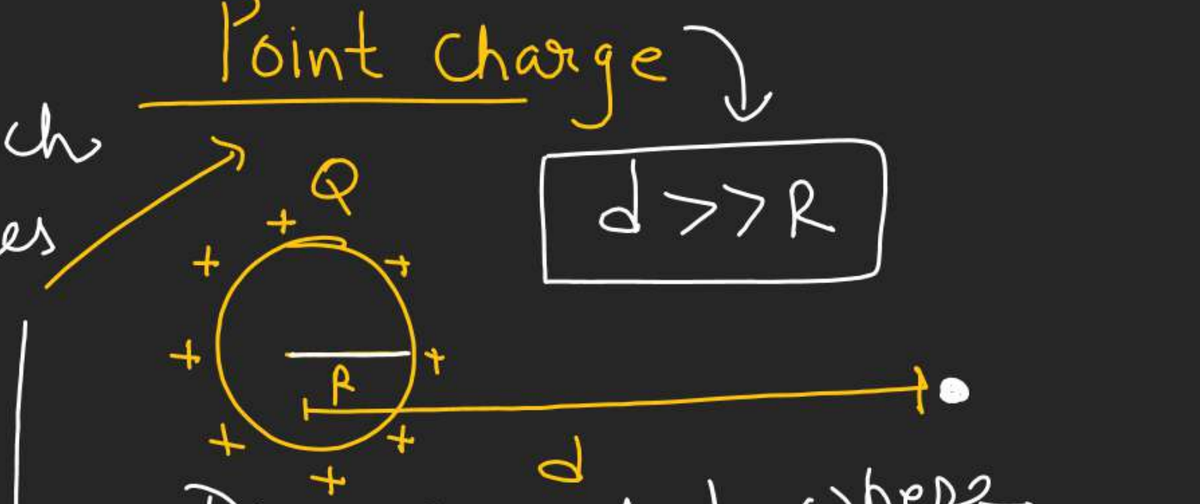
Properties of Coulomb's law

- Like Charge always repell each other and unlike charges attract each other.

Limitation

- Applicable for point Charge.

Point Charge



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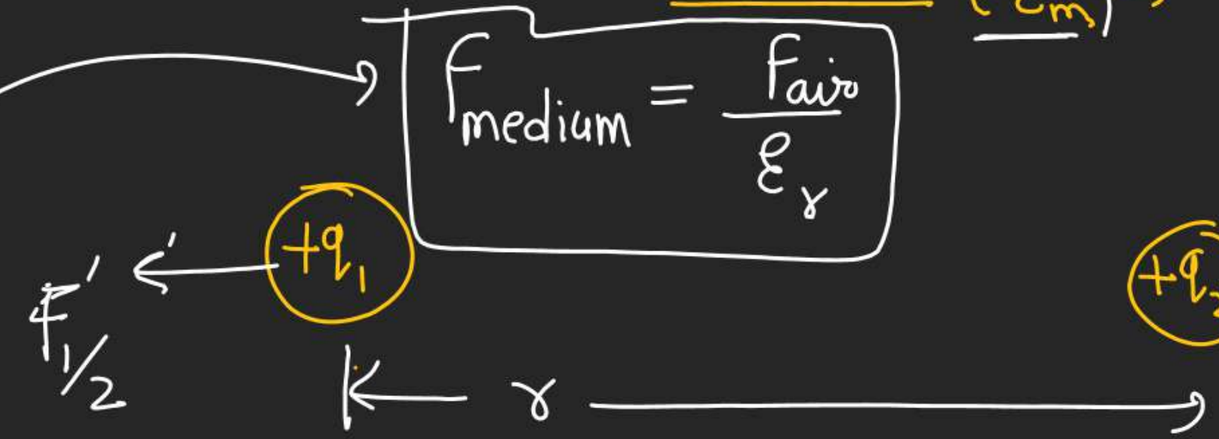
(*) Coulomb's law in Certain medium

Medium (ε_m) →



$$|F'_{1/2}| = |F'_{2/1}| = \frac{1}{4\pi\varepsilon_m}\frac{q_1 q_2}{r^2}$$

$$|F'_{1/2}| = |F'_{2/1}| = \frac{1}{4\pi\varepsilon_0\varepsilon_r}\frac{q_1 q_2}{r^2}$$

$$|F'_{1/2}| = |F'_{2/1}| = \frac{|F_{1/2}|}{\varepsilon_r}$$

ε_0 → Property of a medium

ε_m = Permittivity of a medium.

ε_r = Relative permittivity

$$\varepsilon_r = \frac{\text{Permittivity in Medium}}{\text{Permittivity in air}}$$

$$\varepsilon_r = \frac{\varepsilon_m}{\varepsilon_0}$$

$$\varepsilon_m = \varepsilon_0\varepsilon_r$$

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$\varepsilon_r \rightarrow (K)$ Relative permittivity or Dielectric Constant

Dimension formula

$F = ma$

$= MLT^{-2}$

$\varepsilon_0 = \frac{1}{4\pi} \frac{q_1 q_2}{F \times r^2}$

$[\varepsilon_0] = \frac{A^2 T^2}{MLT^{-2} \cdot L^2}$

$[\varepsilon_0] = [M^{-1} L^{-3} T^4 A^2]$

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

$q = It$

$[q] = [AT]$

K = Constant

$F = \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{r^2}$

$K = 9 \times 10^9 \ \frac{N-m^2}{C^2}$

$\varepsilon_0 = 8.85 \times 10^{-12} \ C^2/N-m^2$