Change in Voltage

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Contents

1 Limit of Classical Physics

Let's say:

$$E = \frac{\varepsilon_O A}{d} \tag{1}$$

if $d \gg 10^{-10}$ the Classical law holds. But anywhere close than that we must use relativistic mechanics.

2 Relativistic mechanics

Relativistic mechanics encloses newtonian mechanics.

2.1 Examples

$$E^2 = (pc)^2 + (mc^2)^2 \tag{2}$$

If:

$$p = 0, E = mc^2 \tag{3}$$

$$m = 0, E = pc = \frac{hc}{\lambda} = hf \tag{4}$$

$$V \ll c = mv \ll mc = pc \ll mc^2 \tag{5}$$

$$\text{Hence:} \tag{6}$$

$$E = \sqrt{p^2c^2 + m^2c^4} = mc^2 + \frac{p^2}{2m} \tag{7}$$

2.2 Two Lines of infinite charge

$$|E| = \frac{\eta}{\varepsilon_O} \tag{8}$$

If E is very large Relativistic effects will allow a electron-positron pairs to be produced. Then is causes polarisation in the electric field, acting like a dielectric material.

2.2.1 Dielectric Constant when E is very large

$$K = \frac{E_O}{E} = \frac{E_0}{E_o - E_{induced}} \tag{9}$$

$$K_{vac} = \frac{E_0}{E_O - N\frac{\frac{1}{2}\varepsilon_O E_0^2}{2mec^2}} \tag{10}$$

$$K_{vac} = \frac{1}{1 - N\frac{\frac{1}{2}\varepsilon_O E_0}{4mec^2}} \tag{11}$$

$K \to \infty$ as $E_O \to \infty$

3 Point Charge

Classical model of Force between two charges:

$$F = \frac{KQ_1Q_2}{R^2} \tag{12}$$

As $R \to 0$, F does not tend to ∞ due to dressed electron effect.
Hence Compton Effect comes into play:

$$\tag{13}$$

4 Link Between Physics