Quiz 3

Constants

permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \mathrm{C^2/(N \cdot m^2)}$
mass of an electron	$m_e = 9.11 \times 10^{-31}$ kg
mass of a proton	$m_p = 1.67 \times 10^{-27}$ kg
nano, n	1×10^{-9}
micro, μ	1×10^{-6}
magnitude of the charge of an electron or proton	$e = 1.6 \times 10^{-19}$ C
electrostatic constant	$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9\ \mathrm{N \cdot m^2/C^2}$
electron-volt	$1\ \mathrm{eV} = 1.6 \times 10^{-19}$ J

Coulomb force

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

Electric field due to a charged particle

$$|\vec{E}| = \frac{1}{4\pi\varepsilon_0}\frac{|q|}{r^2}$$

Electric potential energy of a pair of charged particles

$$U = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r}$$

Electric potential due to a charged particle

$$V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}$$

Potential Difference

Along a path in the x-direction between initial point i and final point f, if $\vec{E}$ is constant or if Δx is small then

$$\Delta V = -E_x \Delta x$$

Often, it's useful to calculate the magnitude of the potential difference. For a 1-D constant electric field, the potential difference a distance d along a direction parallel to the field is:

$$|\Delta V| = Ed$$

Capacitor

A capacitor with plates of area A, plate separation d, and dielectric constant K. Note that $K = 1$ for a vacuum and is approximately 1 for air.

$$\begin{aligned} |\Delta V| &= Ed \\ Q &= C|\Delta V| \\ C &= \frac{K\varepsilon_0 A}{d} \end{aligned}$$