|  |  |  | Units: | Formulae point charges only |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Vectors | $\left\{\begin{array}{l}\text { Electrostatic Force: } \\ \text { Electric Field: }\end{array}\right.$ | $\overrightarrow{F_{e}}$ $\vec{E}$ | $\begin{aligned} & \text { Newtons: } \mathrm{N}=\frac{\mathrm{kg} \mathrm{~m}}{\mathrm{~s}^{2}} \\ & \frac{\text { Newtons }}{\text { Coulomb }}=\frac{\mathrm{N}}{\mathrm{C}}=\frac{\mathrm{v}}{\mathrm{~m}} \end{aligned}$ | $\begin{aligned} & F_{e}=K \frac{\left\|q_{1} q_{2}\right\|}{r^{2}} \\ & E=K \frac{\|q\|}{r^{2}} \end{aligned}$ | $\vec{F}=q \vec{E}$ |
| Scalars | $\left\{\begin{array}{l}\text { Electric Potential Energy: } \\ \text { Electrostatic potential: }\end{array}\right.$ | $\begin{aligned} & U_{\text {elec }} \\ & V \end{aligned}$ | Joules: $\mathrm{J}=\mathrm{N} \mathrm{m}=\mathrm{V}$ C <br> Volts: $\mathrm{V}=\frac{\mathrm{Nm}}{\mathrm{C}}$ | $\begin{aligned} & U_{\text {elec }}=K \frac{q_{1} q_{2}}{r} \\ & V=K \frac{q}{r} \end{aligned}$ | $\begin{aligned} & \Delta U_{\text {elec }}=q \Delta V=-q E \Delta x \\ & \Delta V=-E \Delta x \end{aligned}$ |
|  | Change in Potential Energy Potential Difference | $\begin{aligned} & \Delta U_{\text {elec }} \\ & \Delta V \end{aligned}$ | Volts: V |  |  |

## Capacitors:

Charge:
Capacitance:
C
$U_{c}$
Volts: V

Formulae
point charges only

Newtons: $\mathrm{N}=\frac{\mathrm{kg} \mathrm{m}}{\mathrm{s}^{2}}$
$F_{e}=K \frac{\left|q_{1} q_{2}\right|}{r^{2}}$

$$
\vec{F}=q \vec{E}
$$

Joules: $\mathrm{J}=\mathrm{Nm}=\mathrm{V}$ C
$U_{\text {elec }}=K \frac{q_{1} q_{2}}{r}$
$\Delta U_{\text {elec }}=q \Delta V=-q E \Delta x$
$\Delta V=-E \Delta x$

Potential energy
Joules: J
$U_{c}=1 / 2 Q \Delta V_{C}=1 / 2 C\left(\Delta V_{C}\right)^{2}=1 / 2 Q^{2} / C$
stored in a capacitor

Other useful relationships for capacitors:
$K=8.99 \times 10^{9} \mathrm{Nm}^{2} / \mathrm{C}^{2}$
$\mu=$ micro $=10^{-6}$
$\varepsilon_{o}=\frac{1}{4 \pi K}=8.85 \times 10^{-12} \mathrm{C}^{2} / \mathrm{Nm}^{2}$
Electron charge: $e=-1.6 \times 10^{-19} \mathrm{C}$
$\mathrm{n}=$ nano $=10^{-9}$

$$
\mathrm{p}=\text { pico }=10^{-12}
$$

