Relationships between electric force, field, potential energy and potential.

$\vec{F} = q\vec{E}$ $\quad U = qV$ $\quad \Delta U = q\Delta V$

$\Delta V = -\int \vec{E} \bullet d\vec{s}$ $\quad E_x = -\dfrac{\partial V}{\partial x}$

Point charges.

$F = k\dfrac{q_1 q_2}{r^2}$ $\quad U = k\dfrac{q_1 q_2}{r}$ $\quad E = k\dfrac{q}{r^2}$ $\quad V = k\dfrac{q}{r}$

Uniform electric fields.

$\Delta V = -\vec{E} \bullet \vec{d}$ $\quad E_x = -\dfrac{\Delta V}{\Delta x}$

Gauss's law and charge densities.

$\Phi = \dfrac{1}{\varepsilon_o} q_{enc}$ $\quad q_{enc} = \rho\ V_{enc}$ $\quad q_{enc} = \sigma\ A_{enc}$ $\quad q_{enc} = \lambda\ L_{enc}$

Electric field magnitudes for symmetric charge distributions.

(shell,inside) $E = 0$ $\quad$ *(ball,outside)* $E = k\dfrac{q}{r^2}$ $\quad$ *(line)* $E = \dfrac{\lambda}{2\pi\varepsilon_o r}$ $\quad$ *(sheet)* $E = \dfrac{\sigma}{2\varepsilon_o}$ $\quad$ *(cond. surface)* $E = \dfrac{\sigma}{\varepsilon_o}$

Magnetic force and field, induction.

$\vec{F} = q\vec{v} \times \vec{B}$ $\quad \vec{F} = i\vec{L} \times \vec{B}$ $\quad F = \dfrac{\mu_o L i_1 i_2}{2\pi\, r}$

$r = \dfrac{mv_\perp}{qB}$ $\quad f = \dfrac{qB}{2\pi\, m}$ $\quad p = v_\parallel T$

$d\vec{B} = \dfrac{\mu_o i}{4\pi}\dfrac{d\vec{s} \times \vec{r}}{r^3}$ $\quad \oint \vec{B} \bullet d\vec{s} = \mu_o i_{enc}$

$B_{wire} = \dfrac{\mu_o i}{2\pi\, r}$ $\quad B_{loop} = \dfrac{\mu_o i}{2R}$ $\quad B_{solenoid} = \mu_o in$ $\quad B_{torroid} = \dfrac{\mu_o iN}{2\pi}\dfrac{1}{r}$

$\mathcal{E} = -N\dfrac{d\Phi}{dt}$ $\quad \Phi = \int \vec{B} \bullet d\vec{A}$ $\quad \Phi = \vec{B} \bullet \vec{A}$ $\quad \oint \vec{E} \bullet d\vec{s} = -N\dfrac{d\Phi}{dt}$

Constants.

$k = \dfrac{1}{4\pi\varepsilon_o} = 8.99 \times 10^9\ \dfrac{Nm^2}{C^2}$ $\quad \varepsilon_o = 8.85 \times 10^{-12}\ \dfrac{C^2}{Nm^2}$ $\quad \mu_o = 4\pi \cdot 10^{-7}\ \dfrac{Tm}{A}$

$e = 1.60 \times 10^{-19}$ C $\quad q_{electron} = -e$ $\quad q_{proton} = e$

Crossproduct

$$\vec{A} \times \vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix} = \left(A_y B_z - A_z B_y\right)\hat{i} - \left(A_x B_z - A_z B_x\right)\hat{j} + \left(A_x B_y - A_y B_x\right)\hat{k}$$

Capacitors

$q = CV$

$C = \varepsilon_o \dfrac{A}{d}$ *for a parallel plate capacitor*

$U = \dfrac{1}{2}CV^2 = \dfrac{1}{2}\dfrac{q^2}{C}$ $u = \dfrac{1}{2}\varepsilon_o E^2$

$C_{parallel} = C_1 + C_2$ $q_{parallel} = q_1 + q_2$

$\dfrac{1}{C_{series}} = \dfrac{1}{C_1} + \dfrac{1}{C_2}$ $q_{series} = q_1 = q_2$

Current, Resistivity, Power

$i = \dfrac{dq}{dt}$ $i = \dfrac{\Delta q}{\Delta t}$ *for a constant current*

$\vec{J} = (\mathrm{ne})\,\vec{\mathrm{v}}_{\mathrm{d}}$ $J = \dfrac{i}{A}$ *for a uniform current*

$\vec{E} = \rho\,\vec{J}$ $P = iV$

Resistors

$V = iR$

$R = \rho \dfrac{L}{A}$ *for a conductor of uniform cross-section*

$\dfrac{1}{R_{parallel}} = \dfrac{1}{R_1} + \dfrac{1}{R_2}$ $i_{parallel} = i_1 + i_2$

$R_{series} = R_1 + R_2$ $i_{series} = i_1 = i_2$

$P_R = i^2 R = \dfrac{V^2}{R}$

Circuits, RC circuits

$i_{in} = i_{out}$ *at a node or junction*

$\sum \Delta V = 0$ *around a loop*

For a simple RC circuit (battery, resistor, capacitor in series):

(charging) $q(t) = C\mathcal{E}\,(1 - e^{-t/\tau})$ (discharging) $q(t) = C\mathcal{E}\,e^{-t/\tau}$

$\tau = RC$

Constant Acceleration Kinematics.

$v = v_o + at$ $x = x_o + v_o t + \frac{1}{2} at^2$ $v^2 = v_o^2 + 2\,a\,\Delta x$