<u>CHECK FOR NEGATIVE SIGNS</u> **<u>MAKE SURE CACULATOR IS IN RADIANS OR DEGREES MODE WHEN REQUIRED</u>**

$k = 9.00 \times 10^{9}\ Nm^2/C^2 = 1/(4\pi\varepsilon_0)$ $\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/Nm^2$ $\mu_0 = 4\pi \times 10^{-7} T\text{-}m/A$ $\lambda=Q/length$ $\sigma=Q/area$ $\rho=Q/volume$

$e = 1.6 \times 10^{-19}$ C $\left|\vec{A} \times \vec{B}\right| = AB \sin sin\ \theta$ $\left|\vec{A} \bullet \vec{B}\right| = AB \cos cos\ \theta$ $s = r\theta$ $V_{sphere} = \frac{4}{3}\pi r^3$ $A_{sphere} = 4\pi r^2$

$\vec{F}_{12} = \frac{k|q_1 q_2|}{r_{12}^2}\hat{r}_{12}$

$\vec{E} = \frac{\vec{F}}{q_o}$

$\vec{E}_{point} = \frac{k|q|}{r^2}\hat{r}$

$E_{line} = 2k\frac{|\lambda|}{r}$

$E_{sheet} = \frac{|\sigma|}{2\varepsilon_0}$

$\Phi_E \equiv \int \vec{E}\cdot d\vec{A}$ (flux)

$\Phi_E = \oint \vec{E}\cdot d\vec{A} = \frac{q_{enclosed}}{\varepsilon_0}$

$\Delta U_{A\to B} \equiv - W_{A\to B} = -\int_A^B \vec{F}_E \cdot d\vec{l}$

$\Delta U_r \equiv - \Delta U_{\infty\to r} = k\frac{q_1 q_2}{r}$ (point charges only)

$U_{system} = \sum_{all\ pairs} \frac{kq_i q_j}{r_{ij}}$

$\Delta U_{A\to B} \equiv - W_{A\to B} = - q\int_A^B \vec{E}\cdot d\vec{l}$ (electr potential energy)

$\Delta V_{A\to B} \equiv \frac{\Delta U_{A\to B}}{q} = -\int_A^B \vec{E}\cdot d\vec{l}$ (electr potential)

$\Delta V_{capacitor} = E\Delta y$

$\vec{E} = -\vec{\nabla} V$ $E_x = \frac{\partial V}{\partial x}$

$C \equiv \frac{Q}{V}$ $C = \frac{\kappa\varepsilon_0 A}{d}$ $(where\ \kappa\ is\ dielectric\ constant)$

$E_{apacitor} = \frac{Q^2}{2C} = \frac{QV}{2} = \frac{CV^2}{2}$

$u_{e} = \frac{1}{2}\varepsilon_0 E^2$ (energy density)

$C_p = C_1 + C_2 + C_3 + \ldots$ (parallel)

$C_s = \left(\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \ldots\right)^{-1}$ (series)

$V_p = V_1 = V_2 = V_3 = \ldots..$

$V_s = V_1 + V_2 + V_3 + \ldots.$

$Q_p = Q_1 + Q_2 + Q_3 + \ldots\ldots.$

$Q_s = Q_1 = Q_2 = Q_3 = \ldots\ldots.$

$R_s = R_1 + R_2 + R_3 + \ \ldots.$

$R_p = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ \ldots.\right)^{-1}$

$I \equiv \frac{dq}{dt}$ $V = IR$ $R = \frac{\rho L}{A}$ (ρ = resistivity)

$P = VI = \frac{V^2}{R} = I^2 R$

$\sum \Delta V_n = 0$ $\sum I_{in} = \sum I_{out}$

$q(t) = CV\left(1 - e^{\frac{-t}{RC}}\right)$ (charging) $\tau = RC$

$V(t) = V_{max}\left(1 - e^{\frac{-t}{RC}}\right)$ (charging)

$q(t) = CV\left(e^{\frac{-t}{RC}}\right)$ (discharging)

$I(t) = \frac{V}{R}e^{\frac{-t}{RC}}$ (charging & discharging)

$\vec{F} = I\vec{L} \times \vec{B}$ $\vec{F} = q\vec{v} \times \vec{B}$ $R = \frac{mv}{qB}$ K.E. = $\frac{mv^2}{2}$

$B_{wire} = \frac{\mu_0 I}{2\pi r} = \frac{2x10^{-7} I}{r} Tm/A$ $\vec{\tau} = \vec{\mu} \times \vec{B}$ $\vec{\mu} = NI\vec{A}$

$\varepsilon_{mf} = vLB$ $U = -\vec{\mu} \bullet \vec{B}$ $F = \frac{\mu_0}{2\pi d} I_1 I_2$ L

$\varepsilon_{mf} = -\frac{d\Phi_B}{dt} = -\frac{d}{dt}\int \vec{B} \bullet d\vec{A}$ $\omega = 2\pi f = \frac{2\pi}{T} = \frac{\Delta\theta}{\Delta t}$

$\Phi_B \equiv \int \vec{B}\cdot d\vec{A}$ (flux) $\oint \vec{B}\cdot d\vec{l} = \mu_0 I_{enclosed}$ $\varepsilon_{mf} = vL\left(B_{near} - B_{far}\right)$ $B_{sheet} = \frac{1}{2}\mu_0 \frac{N}{L} I$

$\varepsilon_{mf} = -L\frac{dI}{dt}$ $U_L = \frac{1}{2}LI^2$

RL Circuits:

$V_L(t) = V_{max}e^{-(\frac{R}{L})t}$ (charging & discharging) $\tau = \frac{L}{R}$

$I_L(t) = I_{max}\left(1 - e^{-(\frac{R}{L})t}\right)$ (charging) $I_L(t) = I_{max}e^{-(\frac{R}{L})t}$ (discharging)

LC Circuits:

$\omega = \frac{1}{\sqrt{LC}}$ $Q(t) = Q_{max}cos(\omega_o t + \varphi)$ $I(t) = \omega_0 Q_{max}sin(\omega_o t + \varphi)$ $U_{system} = \frac{1}{2}LI^2 + \frac{1}{2}\frac{Q^2}{C}$

Driven RLC Circuits:

$X_L = \omega L$ $X_C = \frac{1}{\omega C}$ $tan\varphi = \frac{X_L - X_C}{R}$ t = θ/ω ω = 2πf $\omega_o = \frac{1}{\sqrt{LC}}$ (resonance only)

$I_{max} = \frac{\varepsilon_{max}}{Z} = \frac{\varepsilon_{max}}{\sqrt{R^2 + (X_L - X_C)^2}}$ $\langle P_{generator}\rangle = \frac{1}{2}I_{max}\varepsilon_{max}cos\varphi$ v = sqrt(t/u) (u = mass/lenght)

Electromagnetic Waves:

κ = 2π/λ B = E/c ω = 2πf $v = \lambda f$ $u_{energy\ density} = ½\ \varepsilon_o E^2$ $\vec{S} = \frac{\vec{E}\times\vec{B}}{\mu_o}$ c = 3 x 10^8 m/s

$E_x = E_0 cos(kz - \omega t + \varphi)$ $B_y = \frac{E_0}{c}cos(kz - \omega t + \varphi)$ $I_{ntensity} = \frac{\langle Power\rangle}{Area} = \frac{1}{2}c\varepsilon_o E_o^2$