Equations for Exam 3

Generally:

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

$$k = \frac{1}{4\pi\varepsilon_o} = 8.99\times10^{9}\, N\cdot m^2 / C^2$$

$$\varepsilon_o = 8.85\times10^{-12}\, C^2/(N\cdot m^2)$$

$$e = 1.6\times10^{-19}\, C$$

$$\Delta V_{AB} = \frac{-W_{AB}}{q} = -\int_A^B \vec{E}\cdot d\vec{l} = \frac{\Delta PE}{q}$$

$$1eV = 1.6\times10^{-19}\, J$$

$$E_x = \frac{-\partial V}{\partial x} \qquad E_y = \frac{-\partial V}{\partial y} \qquad E_z = \frac{-\partial V}{\partial z}$$

Capacitance:

$$C = \frac{Q}{V}$$

$$U = \frac{1}{2}CV^2 = \frac{Q^2}{2C} = \frac{1}{2}QV$$

$$C_{parallel} = C_1 + C_2 + \ldots$$

$$\frac{1}{C_{series}} = \frac{1}{C_1} + \frac{1}{C_2} + \ldots$$

Current, Voltage and Resistance:

$$I = \frac{dQ}{dt}$$

$$i = nAv_d$$

$$v_d = \frac{e\tau}{m}E$$

$$J = \frac{I}{A} = \sigma E$$

$$\sigma = \frac{ne^2\tau}{m}$$

$$\rho = \frac{1}{\sigma}$$

$$I = qnAv_d$$

$$\Delta V = IR$$

$$R = \rho\frac{L}{A}$$

$$R_{series} = R_1 + R_2 + \ldots$$

$$\frac{1}{R_{parallel}} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$$

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

Kirchhoff:

$$\sum \Delta V = 0$$

$$\sum I_{in} = \sum I_{out}$$

Potential and Potential Energy:

$$U_{elec} = U_0 + qEs$$

$$U_{elec} = \frac{Kq_1q_2}{r}$$

$$U_{elec} = \sum_{i<j}\frac{Kq_iq_j}{r_{ij}}$$

$$V \equiv \frac{U_{elec}}{q}$$

$$V = \left(\frac{U_{elec}}{q} = \frac{qEs}{q}\right) = Es$$

$$V = \left(\frac{U_{elec}}{q'} = \frac{\frac{kqq'}{r}}{q'}\right) = \frac{kq}{r} = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}$$

$$V = \sum_i \frac{Kq_i}{r_i}$$

Discharging a Capacitor

$Q = Q_0 e^{-t/\tau}$ where τ=RC

$$\Delta V_C = Q/C = \frac{Q_0}{C}e^{-t/\tau} = \Delta V_0 e^{-t/\tau}$$

$$I = I_0 e^{-t/\tau}$$

Charging a Capacitor

$Q = Q_0(1 - e^{-t/\tau})$ where τ=RC

$$\Delta V_C = \Delta V_0(1 - e^{-t/\tau})$$

$$I = I_0 e^{-t/\tau}$$