Equations for Exam 2

Gravitation:

$$F_G = \frac{Gm_1m_2}{r^2}$$

$G = 6.67 \times 10^{-11}$ N-m^2/kg^2

$$\vec{g} = \vec{F}_G \Big/ m$$

$$U(r) = \frac{-GMm}{r}$$

Electric Force and Electric Field:

$$F_E = \frac{k|q_1||q_2|}{r^2}$$

$$k = 8.99\times10^9 N\frac{m^2}{C^2} \approx 9\times10^9 N\frac{m^2}{C^2}$$

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

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

$\vec{E} = \frac{kQ}{r^2}\hat{r}$ electric field of point charge

$E = \frac{\eta}{\varepsilon_o}$ electric field of capacitor

$\vec{F}_E = q\vec{E}$ force on charge q in electric field $\vec{E}$

Electric potential energy and electric potential

$$\Delta U_{el} = -W_{AB} = -\int_A^B \vec{F}\cdot d\vec{l}$$

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

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

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

Electric Potential Energy

For charge q in **uniform electric field** (plate capacitor):

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

If $U_0 = 0$ the negative plate: $U_{elec} = qEs$

Two point charges: $U_{elec} = \frac{Kq_1q_2}{r}$

Where PE=0 at $r = \infty$

Multiple point charges: $U_{elec} = \sum_{i<j} \frac{Kq_iq_j}{r_{ij}}$

Electric Potential:

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

Electric Potential in a plate capacitor:

$V = Es$, where s=0 at negative plate

Electric Potential of a point charge:

$V = \frac{kq}{r} = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}$, where V=0 at $r = \infty$

Electric Potential for Multiple Point Charges (just add 'em)

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

Capacitance:

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

$$U = \frac{1}{2}C\Delta V^2 = \frac{Q^2}{2C} = \frac{1}{2}Q\Delta V$$

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

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

Gauss' Law: $\Phi_E = \oint \vec{E}\cdot\overrightarrow{dA} = \frac{q_{\text{enclosed}}}{\epsilon_0}$