Cheat Sheet — Midterm 2

PHYS 142 (Summer 2014)

Constants:

$$\epsilon_0 = 8.9 \times 10^{-12}\ C^2/N \cdot m^2 \qquad \mu_0 = 4\pi \times 10^{-7}\ Wb/A \cdot m \qquad g = 9.8\ m/s^2$$

$$e = 1.6 \times 10^{-19}\ C \qquad m_e = 9.1 \times 10^{-31}\ kg \qquad m_p = 1.7 \times 10^{-27}\ kg \qquad c = 3.0 \times 10^8\ m/s$$

Charges, Currents, and the Electromagnetic Field

Forces on Charges and Currents:

$$\vec{F} = q(\vec{E} + \vec{v} \times \vec{B}) \qquad \vec{F} = \int I\,d\vec{\ell} \times \vec{B}$$

Flux:

$$\Phi_E = \iint_S \vec{E} \cdot \hat{n}\,dA \qquad \Phi_B = \iint_S \vec{B} \cdot \hat{n}\,dA$$

Maxwell's Equations

$$\iint_A \vec{E} \cdot \hat{n}\,dA = \frac{Q_{enc}}{\epsilon_0} \qquad \iint_A \vec{B} \cdot \hat{n}\,dA = 0 \qquad \oint_C \vec{E} \cdot d\vec{\ell} = -\frac{d\Phi_B}{dt} \qquad \oint_C \vec{B} \cdot d\vec{\ell} = \mu_0 I_{enc} + \mu_0\epsilon_0 \frac{d\Phi_E}{dt}$$

Sources of Electric and Magnetic Field

$$\vec{E} = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}\hat{r} \qquad \vec{E} = \frac{1}{4\pi\epsilon_0}\int \frac{dq}{r^2}\hat{r} \qquad \vec{B} = \frac{\mu_0}{4\pi}\frac{q\vec{v} \times \hat{r}}{r^2} \qquad \vec{B} = \frac{\mu_0}{4\pi}\int \frac{I\,d\vec{\ell} \times \hat{r}}{r^2}$$

Electrostatic Potential:

$$V = \frac{1}{4\pi\epsilon_0}\int \frac{dq}{r} \qquad V_a - V_b = \int_a^b \vec{E} \cdot d\vec{\ell} \qquad \vec{E} = -\vec{\nabla}V = -\frac{\partial V}{\partial x}\hat{i} - \frac{\partial V}{\partial y}\hat{j} - \frac{\partial V}{\partial z}\hat{k}$$

Electric Dipole:

$$\vec{p} = q\vec{d} \qquad \vec{\tau} = \vec{p} \times \vec{E} \qquad U = -\vec{p} \cdot \vec{E}$$

Magnetic Dipole:

$$\vec{\mu} = IA\hat{n} \qquad \vec{\tau} = \vec{\mu} \times \vec{B} \qquad U = -\vec{\mu} \cdot \vec{B}$$

Energy in Fields:

$$U = \frac{1}{2}\epsilon_0 E^2 + \frac{1}{2\mu_0}B^2$$

Motion in B-Field:

$$R = \frac{mv}{|q|B}$$

B-Fields of Infinite Objects:

$$B = \frac{\mu_0 I}{2\pi r}\ \text{(wire)} \qquad B = \mu_0 n I\ \text{(solenoid)}$$

Electrical Circuits

Current:

$$I = \frac{dQ}{dt} = n|q|v_d A \qquad \vec{J} = n q \vec{v}_d \qquad r = \frac{\mathcal{E}}{I}$$

Kirchoff's Rules:

$$\sum_{loop} V = 0 \qquad \sum_{junction} I = 0$$

Faraday's Law:

$$\mathcal{E} = -N\frac{d\Phi_B}{dt}$$

Capacitors:

$$C = \frac{Q}{V} \qquad \frac{1}{C_{eq}} = \sum_{i=1}^{n} \frac{1}{C_i}\ \text{(Series)} \qquad C_{eq} = \sum_{i=1}^{n} C_i\ \text{(Parallel)} \qquad U = \frac{1}{2}CV^2 = \frac{Q^2}{2C}$$

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