UNC-CH PHYS117 Placement Exam

Tear this page off when instructed to begin.
Before starting the exam, fill out the next page (p3) completely.

Coulomb's Law: $F_{elec} = \frac{1}{4\pi\varepsilon}\frac{q_1 q_2}{r_{12}^2}$ $k = \frac{1}{4\pi\varepsilon_0}$ = 9×10^9 Nm^2/C^2 $\varepsilon_0 = 8.85\times10^{-12}$ C^2/Nm^2

Electric field: $\vec{E} = \frac{1}{4\pi\varepsilon}\frac{Q}{r^2}\hat{r}$ $\vec{F}_{elec} = q\vec{E}$ Gauss's Law: $\oiint_{surface} \vec{E}\bullet d\vec{S} = \frac{Q_{enclosed}}{\varepsilon_0}$

Potential Energy: $\Delta PE = -\frac{qQ}{4\pi\varepsilon r}$ Potential: $\Delta V = \Delta PE / q = -\frac{Q}{4\pi\varepsilon r}$

Capacitance: $C = \frac{Q}{V} = \varepsilon_0 \frac{A}{d}$

Ohm's Law: $R = \frac{V}{I} = \rho\frac{L}{A}$ (ohms) Circuit power: $P = VI = I^2R = V^2/R$ (Watts)

Resistors in series and parallel:
Series: $R_{eq} = R_1 + R_2 + \ldots$ Parallel: $1/R_{eq} = 1/R_1 + 1/R_2 + \ldots$

Capacitors in series and parallel:
Series: $1/C_{eq} = 1/C_1 + 1/C_2 + \ldots$ Parallel: $C_{eq} = C_1 + C_2 + \ldots$

Magnetic force on an individual moving charge: $\vec{F}_{mag} = q\vec{v}\times\vec{B}$
Magnetic force on a linear current of length L: $\vec{F}_{mag} = L\vec{I}\times\vec{B}$

Circular motion in a magnetic field: $r = \frac{mv}{qB}$ $T_{orbit} = \frac{2\pi m}{qB} = \frac{2\pi r}{v}$

Ampere's Law: $\oint_{contour} \vec{B}\bullet d\vec{\ell} = \mu_0 I_{enclosed}$ $\mu_0 = 4\pi\times10^{-7}$ Tesla-m/Ampere

Flux: $\Phi = \oiint_{surface} \vec{B}\bullet d\vec{S}$ Faraday's Law: $\mathrm{emf}_{induced} = -\frac{d\Phi}{dt}$

AC circuits

$V_{rms} = I_{rms}Z$ $P_{avg} = V_{rms}I_{rms} = I_{rms}^2 Z = \frac{V_{rms}^2}{Z}$ where Z = impedance

$Z_{resistor} = R$ $Z_{capacitor} = 1/\omega C$ $Z_{inductor} = \omega L$

Transient circuits: $\omega_0 = \frac{1}{\sqrt{LC}}$ $\tau = RC$ $\tau = L/R$

Electromagnetic wave power: $\vec{E} \times \vec{B}$

$c = \lambda f$ $E = cB$ $k = 2\pi/\lambda$ $\omega = 2\pi/T = 2\pi f$

Polarized light transmission through one polarizer: $I = I_0 cos^2\theta$
Unpolarized light transmission through one polarizer: $I = \frac{1}{2} I_0$

Law of Reflection: $\theta_{reflected} = \theta_{incident}$ Snell's law: $n_1 \sin\theta_1 = n_2 \sin\theta_2$

Mirror and Lens Equation:

$$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \qquad M = -\frac{d_i}{d_o}$$

Two-slit interference:
Constructive: $d\sin\theta = m\lambda$ $m = 0, \pm1, \pm2, \ldots$
Destructive: $d\sin\theta = (m - \frac{1}{2})\lambda$ $m = \pm1, \pm2, \ldots$

Single slit diffraction, width W, destructive interference: $W\sin\theta = m\lambda_0$ m = ±1, ±2, …

Photon energy and momentum: $E = hf = hc/\lambda$, $p = h/\lambda$ deBroglie $\lambda = h/p$

prefixes: nano = 10^{-9} micro = 10^{-6} Mega = 10^6

Work Kinetic Energy Theorem: $\Delta KE = Work$ $KE = \frac{1}{2}mv^2$ $p = mv$

Kinematic equations: $\vec{r} - \vec{r}_0 = \vec{v}_0 t + \frac{1}{2}\vec{a}t^2$ $v^2 - v_0^2 = 2\vec{a} \bullet (\vec{r} - \vec{r}_0)$

$g = 9.8$ m/s^2 $c = 3\times10^8$ m/s 1 eV = 1.6×10^{-19} J

10,000 Gauss = 1 Tesla $m_e = 9.1\times10^{-31}$ kg

$e = 1.6\times10^{-19}$ C $h = 6.63\times10^{-34}$ Js