Physics 1214, Formula sheet for Final

Electric field and potential

Electric force on a point charge: $\vec{F} = q\vec{E}$

Electric field of a point charge: $E = k\dfrac{q}{r^2}$

Force between two point charges: $F = k\dfrac{q_1 q_2}{r^2}$

Electric potential of a point charge: $V = k\dfrac{q}{r}$

Potential energy of two point charges: $U = k\dfrac{q_1 q_2}{r}$

Capacitors

Capacitance: $C = \dfrac{Q}{V}$

Parallel-plate capacitor: $C = \varepsilon_0 \dfrac{A}{d}$

Electric field in a capacitor: $E = \dfrac{V}{d}$

Capacitors in parallel: $C = C_1 + C_2$

Capacitors in series: $\dfrac{1}{C} = \dfrac{1}{C_1} + \dfrac{1}{C_2}$

Resistors

Ohm's law: $I = \dfrac{V}{R}$

Resistance and resistivity: $R = \rho\dfrac{l}{A}$

Resistors in series: $R = R_1 + R_2$

Resistors in parallel: $\dfrac{1}{R} = \dfrac{1}{R_1} + \dfrac{1}{R_2}$

Kirchhoff's rules

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

Loops: $\sum \mathcal{E} = \sum IR$

Magnetic field and magnetic forces

Magnetic force on a point charge: $F = qvB\sin\varphi$

Magnetic field of a wire: $B = \dfrac{\mu_0 I}{2\pi r}$

Force between parallel wires: $F = l\dfrac{\mu_0 I_1 I_2}{2\pi r}$

Magnetic field of a solenoid: $B = \mu_0 \dfrac{N}{l} I$

Electromagnetic induction

Magnetic flux through a loop: $\Phi = BA\cos\varphi$

Faraday's law: $\mathcal{E} = -\dfrac{\Delta\Phi}{\Delta t}$

Slide-wire generator: $\mathcal{E} = -Blv$

Loop rotating in magnetic field: $\mathcal{E} = \omega AB\sin\omega t$

Electromagnetic waves

$$k = \frac{2\pi}{\lambda} \qquad f = \frac{\omega}{2\pi} \qquad c = \frac{\omega}{k} = \lambda f$$

Electric field energy density: $u_E = \frac{1}{2}\varepsilon_0 E^2$

Magnetic field energy density: $u_B = \frac{1}{2\mu_0} B^2$

Geometric optics

Reflection: $\theta_i = \theta_r$

Refraction: $n_a \cos\theta_a = n_b \cos\theta_b$

Spherical mirror: $f = \frac{R}{2}$

Thin lens: $\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

Positions of the object and the image: $\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$

Lateral magnification: $m = -\frac{s'}{s}$

Compound lenses: $\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$

Interference and diffraction

Double slit interference: maxima at $y_m = Rm\frac{\lambda}{d}$, minima at $y_m = R\left(m + \frac{1}{2}\right)\frac{\lambda}{d}$

Single slit diffraction: minima at $y_m = Rm\frac{\lambda}{a}$

Grating: $d\sin\theta = m\lambda$

Photons, electrons, and atoms

De Broglie wavelength: $\lambda = \frac{h}{p}$

Photoelectric effect: $eV_0 = hf - \varphi$

Bohr's atom model: $E_n = -\frac{13.6\text{ eV}}{n^2}$

Useful constants:

$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2/(\text{N}\cdot\text{m}^2)$

$k = 1/4\pi\varepsilon_0 = 8.99 \times 10^9\ \text{N}\cdot\text{m}^2/\text{C}^2$

$\mu_0 = 4\pi \times 10^{-7}\ \text{T}\cdot\text{m/A}$

$c = 3 \times 10^8\ \text{m/s}$

$h = 6.626 \times 10^{-34}\ \text{J}\cdot\text{s} = 4.136 \times 10^{-15}\ \text{eV}\cdot\text{s}$

$e = 1.60 \times 10^{-19}\ \text{C}$