General Physics II Formula Sheet

Electrostatics

Coulomb's Law: The force between two point charges.

$$F = k\frac{|q_1 q_2|}{r^2}, \quad k = \frac{1}{4\pi\epsilon_0}$$

where F is the force, q_1, q_2 are charges, r is the distance, $k \approx 8.99 \times 10^9\,\mathrm{N\,m^2\,C^{-2}}$, $\epsilon_0 \approx 8.85 \times 10^{-12}\,\mathrm{C^2\,N^{-1}\,m^2}$.

Electric Field: Due to a point charge.

$$E = \frac{F}{q} = k\frac{|q|}{r^2}$$

where E is the electric field, q is the source charge.

Electric Potential Energy:

$$U = k\frac{q_1 q_2}{r}$$

Electric Potential:

$$V = k\frac{q}{r}, \quad V = -\int E\,dr$$

Electric Circuits

Ohm's Law:

$$V = IR$$

where V is voltage, I is current, R is resistance.

Power:

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

Resistors in Series:

$$R_{\text{eq}} = R_1 + R_2 + \cdots + R_n$$

Resistors in Parallel:

$$\frac{1}{R_{\text{eq}}} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_n}$$

Capacitors in Series:

$$\frac{1}{C_{\text{eq}}} = \frac{1}{C_1} + \frac{1}{C_2} + \cdots + \frac{1}{C_n}$$

Capacitors in Parallel:

$$C_{\text{eq}} = C_1 + C_2 + \cdots + C_n$$

Capacitor Energy:

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

Magnetism

Magnetic Force on a Moving Charge:

$$F = q(v \times B), \quad F = qvB\sin\theta$$

where B is the magnetic field, v is velocity, θ is the angle between v and B.

Magnetic Force on a Current-Carrying Wire:

$$F = I(L \times B), \quad F = ILB\sin\theta$$

where L is the length of the wire.

Biot-Savart Law:

$$d\mathbf{B} = \frac{\mu_0}{4\pi}\frac{I\,d\ell \times \hat{\mathbf{r}}}{r^2}, \quad \mu_0 = 1.256\,637\,061\,4 \times 10^{-6}\,\mathrm{T\,m\,A^{-1}}$$

Magnetic Field of a Long Straight Wire:

$$B = \frac{\mu_0 I}{2\pi r}$$

Ampere's Law:

$$\oint B \cdot dl = \mu_0 I_{\text{enc}}$$

Electromagnetic Induction

Faraday's Law:

$$\mathcal{E} = -\frac{d\Phi_B}{dt}, \quad \Phi_B = \int B \cdot dA$$

where $\mathcal{E}$ is the induced EMF, Φ_B is the magnetic flux.

Lenz's Law: The direction of induced current opposes the change in magnetic flux.

Inductance:

$$\mathcal{E} = -L\frac{dI}{dt}, \quad U = \frac{1}{2}LI^2$$

where L is inductance, U is stored energy.

Electromagnetic Waves

Speed of Light:

$$c = \frac{1}{\sqrt{\mu_0 \epsilon_0}} \approx 3.00 \times 10^8\,\mathrm{m\,s^{-1}}$$

Wave Equation:

$$E = E_{\text{max}}\sin(kx - \omega t), \quad B = B_{\text{max}}\sin(kx - \omega t)$$

where $E_{\text{max}} = cB_{\text{max}}$, k is the wave number, ω is angular frequency.

Poynting Vector:

$$S = \frac{1}{\mu_0}(E \times B), \quad I = S_{\text{avg}} = \frac{E_{\text{max}} B_{\text{max}}}{2\mu_0}$$

Optics

Law of Reflection:

$$\theta_i = \theta_r$$

Snell's Law:

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

where n is the index of refraction.

Lens/Mirror Equation:

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

where f is focal length, d_o is object distance, d_i is image distance.

Magnification:

$$m = -\frac{d_i}{d_o}$$