Constants

Permittivity of vacuum	$\varepsilon_0 = 8.854 \cdot 10^{-12}$ F/m
Coulomb's force constant	$k = \dfrac{1}{4\pi\varepsilon_0} = 8.99 \cdot 10^9$ N m^2/C^2
Electron charge	$q_e = 1.602 \cdot 10^{-19}$ C
Permeability of vacuum	$\mu_0 = 4\pi \cdot 10^{-7}$ H/m
Electron mass	$m_e = 9.109 \cdot 10^{-31}$ kg = 0.0005486 u
electron-volt	1 eV $= 1.602 \cdot 10^{-19}$ J
Rydberg constant	$R_{\mathrm{H}} = \dfrac{E_1}{hc} = 1.097 \cdot 10^7$ m^{-1}
Speed of light in vacuum	$c = \dfrac{1}{\sqrt{\varepsilon_0 \mu_0}} = 2.998 \cdot 10^8$ m/s
Hydrogen ground state	$E_1 = -\dfrac{m_e c^2 \alpha^2}{2} = -13.61$ eV
Planck's constant	$h = 6.626 \cdot 10^{-34}$ J s

Electric Forces and Fields

$$\vec{F}_{12} = k\frac{q_1 q_2}{r^2}\hat{r}_{12} \qquad \vec{E} = \frac{\vec{F}}{q} \qquad \vec{E} = \int d\vec{E} = \int \frac{k\,dq}{r^2}\hat{r} \qquad \text{point charge: } E = \frac{kq}{r^2}$$

$$\text{Parallel plate capacitor: } E = \frac{q}{\varepsilon_0 A} \qquad \text{Gauss' law: } \Phi^{\text{elec}} = \oint \vec{E} \cdot d\vec{A} = \frac{q^{\text{enc}}}{\varepsilon_0}$$

$$\rho = \frac{dq}{dV} \qquad \sigma = \frac{dq}{dA} \qquad \lambda = \frac{dq}{dl}$$

Electric Potential

$$\Delta U^{\text{elec}} = U_B^{\text{elec}} - U_A^{\text{elec}} = -\int_A^B q\vec{E} \cdot d\vec{s} \qquad \Delta V = V_B - V_A = -\int_A^B \vec{E} \cdot d\vec{s}$$

$$V = k\int \frac{dq}{r} \qquad \text{point charge: } V = \frac{kq}{r} \qquad E_i = -\frac{\partial V}{\partial i}, \quad i = x, y, z$$

Circuits

$$I = \frac{dq}{dt} \qquad V = IR \qquad P = IV \qquad I_{\text{RMS}} = \frac{I_0}{\sqrt{2}} \qquad V_{\text{RMS}} = \frac{V_0}{\sqrt{2}}$$

$$R_{\text{s}} = R_1 + R_2 + \cdots \qquad \frac{1}{R_{\text{p}}} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots \qquad \frac{1}{C_{\text{s}}} = \frac{1}{C_1} + \frac{1}{C_2} + \cdots \qquad C_{\text{p}} = C_1 + C_2 + \cdots$$

Capacitors

$$q = CV \qquad \kappa = \frac{E_0}{E} \qquad \text{for parallel plate: } C = \frac{\kappa\varepsilon_0 A}{d} \qquad U^{\text{elec}} = \frac{1}{2}CV^2$$

$$\text{RC charging: } q = q_0(1 - e^{-t/RC}) \qquad \text{RC discharging: } q = q_0 e^{-t/RC} \qquad \tau = RC$$

Magnetic Forces and Fields

$\vec{F}^{\text{mag}} = q\vec{v} \times \vec{B}$ circular path: $r = \dfrac{mv}{|q|\,B}$ $d\vec{F}^{\text{mag}} = |I|\,d\vec{L} \times \vec{B}$ $\vec{\tau} = \vec{\mu} \times \vec{B}$

$\vec{\mu} = NI\vec{A}$ $U(\theta) = -\vec{\mu} \cdot \vec{B}$

long wire: $B = \dfrac{\mu_0\,|I|}{2\pi r}$ center of circular loop: $B = N\dfrac{\mu_0\,|I|}{2R}$

solenoid: $B = \mu_0 n\,|I|$ Ampere's law: $\oint \vec{B} \cdot d\vec{s} = \mu_0 I^{\text{enc}}$

Faraday's law: $\varepsilon = -N\,\dfrac{d\Phi^{\text{mag}}}{dt}$ $\Phi^{\text{mag}} = \int \vec{B} \cdot d\vec{A}$

$$d\vec{B} = \frac{\mu_0}{4\pi}\,\frac{I\,d\vec{l} \times \hat{r}}{r^2}$$

Optics

$\dfrac{1}{o} + \dfrac{1}{i} = \dfrac{1}{f} = \dfrac{2}{r}$ $m = \dfrac{h'}{h} = -\dfrac{i}{o}$

$n_1 \sin\theta_1 = n_2 \sin\theta_2$ $\sin\theta_{\text{c}} = \dfrac{n_2}{n_1}$

single slit: $a\sin\theta = m\lambda,\ m = 1, 2, 3, \ldots$

double slit and diffraction grating:

bright: $d\sin\theta = m\lambda,\ m = 0, 1, 2, \ldots$

dark: $d\sin\theta = \left(m + \dfrac{1}{2}\right)\lambda,\ m = 0, 1, 2, \ldots$

Electromagnetic waves

wave speed: $c = \dfrac{1}{\sqrt{\varepsilon_0 \mu_0}}$ $c = \lambda f$

$$u^{\text{total}} = u^{\text{elec}} + u^{\text{mag}} = \frac{1}{2}\varepsilon_0 E^2 + \frac{B^2}{2\mu_0}$$

$\vec{S} = \dfrac{\vec{E} \times \vec{B}}{\mu_0}$ $\vec{E} = \vec{E}^{\text{max}} \sin(kz - \omega t)$ $\vec{B} = \vec{B}^{\text{max}} \sin(kz - \omega t)$

$I = I_0 \cos^2\theta$

Quantum Physics

$\dfrac{1}{\lambda} = R\left(\dfrac{1}{n_{\text{f}}^2} - \dfrac{1}{n_{\text{i}}^2}\right)$ for hydrogen: $E_n = \dfrac{-13.61\text{ eV}}{n^2},\ \ n = 1, 2, 3, \ldots$