Some useful constants and formulae

Speed of light	$c = 2.9979\times10^{8}\ m/s$	Gravitational constant	$G = 6.67\times10^{-11}\ N\cdot m^2/kg^2$
Permittivity constant	$\varepsilon_0 = 8.85\times10^{-12}\ F/m$	Permeability constant	$\mu_0 = 1.26\times10^{-6}\ H/m$
Near point P_N = 25 cm		Planck's constant	h = 6.63 x 10^{-34} J.s = 4.14 x 10^{-15} eV.s
e = 1.60 x 10^{-19} C		atomic mass $\boldsymbol{m}(^1{}_1H)$ =1.007825 u	
m_e = 9.11 x 10^{-31} kg = 0.000549 u		1 u = 1.6605 x 10^{-27} kg = 931.5 MeV/c^2	
m_p = 1.6726 x 10^{-27} kg = 1.00728 u		1eV = 1.602 x 10^{-19} J	
m_N = 1.6749 x 10^{-27} kg = 1.008665 u		$hc = 1240\ eV\cdot nm$	

Transverse Waves:

$$y(x,t) = y_m \sin(kx-\omega t) \qquad k = \frac{2\pi}{\lambda} \qquad \omega = \frac{2\pi}{T} = 2\pi f \qquad v = \frac{\lambda}{T} = \lambda f = \frac{\omega}{k}$$

Electromagnetic Waves:

$$E(x,t) = E_m \sin(kx-\omega t) \qquad B(x,t) = B_m \sin(kx-\omega t) \qquad \frac{E_m}{B_m} = c$$

$$E_{rms} = \frac{E_m}{\sqrt{2}} \qquad c = \frac{1}{\sqrt{\varepsilon_0\mu_0}} \qquad \vec{S} = \frac{1}{\mu_0}\vec{E}\times\vec{B}$$

$$S = \frac{1}{\mu_0}EB = \frac{1}{c\mu_0}E^2 \qquad I = \frac{1}{c\mu_0}E_{rms}^2 \qquad I = \frac{P_{source}}{4\pi r^2}$$

Unpolarized Light: $I = \frac{1}{2}I_0$ **Fully Polarized Light:** $I = I_0\cos^2\theta$

Law of reflection $\theta_1' = \theta_1$ **Snell's Law** $n_1\sin\theta_1 = n_2\sin\theta_2$

Total internal reflection $\theta_c = \sin^{-1}\frac{n_2}{n_1}$ **Brewster angle** $\theta_B = \tan^{-1}\frac{n_2}{n_1}$

Total Absorption $p_c = \frac{I}{c}$ **Total Reflection** $p_r = \frac{2I}{c}$

Mirrors and Lenses:

Spherical Mirrors/Thin Lenses: $\frac{1}{p}+\frac{1}{i}=\frac{1}{f} \qquad m = -\frac{i}{p}$

Spherical Mirrors: $f = \frac{r}{2}$

Refracting Surface: $\frac{n_1}{p}+\frac{n_2}{i}=\frac{n_2-n_1}{r} \qquad i = -\frac{n_2}{n_1}p$

$$n = \frac{c}{v} \qquad \lambda_n = \frac{\lambda}{n} \qquad \Delta\phi = \frac{2\pi L}{\lambda}(n_2-n_1) \qquad \Delta\phi = \frac{2\pi\Delta L}{\lambda}$$

magnifier $m_\theta = P_N/f$

microscope $m = -[l\ P_N]/f_{ob}f_{ey}$

telescope $m = -f_{ob}/f_{ey}$

Constructive Interference: $\Delta L = d\sin\theta = m\lambda\ , \quad m = 0,1,2,\ldots$

Destructive Interference: $\Delta L = d\sin\theta = \left(m + \frac{1}{2}\right)\lambda \qquad m = 0,\ 1,\ 2,...$

Intensity in double-slit interference $I = 4I_0\cos^2\frac{\phi}{2} \qquad \phi = \frac{2\pi d}{\lambda}\sin\theta$

Interference from thin films: Maxima: $2L = \left(m + \frac{1}{2}\right)\frac{\lambda}{n_2}$ **Minima:** $2L = m\frac{\lambda}{n_2}$

Single-slit Diffraction:

Minima $a\sin\theta = m\lambda$ **Intensity** $I(\theta) = I_m\left(\frac{\sin\alpha}{\alpha}\right)^2$, where $\alpha = \frac{\phi}{2} = \frac{\pi a}{\lambda}\sin\theta$

Resolvability:

Resolving angle $\theta = 1.22\lambda/a$ circular aperture $\theta = 1.22\lambda/D$
Resolving power RP = θL

Resolving power for microscope (telescope) $RP = 1.22\ \lambda f/D$

Double-slit Diffraction:

$I(\theta) = I_m(\cos^2\beta)\left(\frac{\sin\alpha}{\alpha}\right)^2$, where $\alpha = \frac{\pi a}{\lambda}\sin\theta$ and $\beta = \frac{\pi d}{\lambda}\sin\theta$ **Maxima lines** $d\sin\theta = m\lambda$

Diffraction gratings:

Half-width of line $\Delta\theta_{hw} = \frac{\lambda}{Nd\cos\theta}$

Photon Energy $E = hf$ **Photoelectric effect** $hf = W + KE$ **Photon Momentum** $p = \frac{hf}{c} = \frac{h}{\lambda}$

Wien's law $\lambda_p \bullet T = 2.90 \times 10^{-3}$ mK

Compton scattering $\lambda' = \lambda + (h/mc)(1-\cos\Phi)$

de Broglie Wavelength $\lambda = h/p$, $f = E/h$

Time-independent Schrödinger Equation $\frac{d^2\psi(x)}{dx^2} + \frac{8\pi^2 m}{h^2}[E - U(x)]\psi(x) = 0$

Heisenberg Uncertainty Principle

$\Delta x \cdot \Delta p_x \geq h/2\pi$

$\Delta y \cdot \Delta p_y \geq h/2\pi \qquad \Delta E\ \Delta t \geq \hbar$

$\Delta z \cdot \Delta p_z \geq h/2\pi$

Wave function in 1-D Infinite Well

$\psi_x(x) = A\sin\left(\frac{n\pi}{L}x\right)$

Energy Level In 1-d Infinite Well

$E_n = \left(\frac{h^2}{8mL^2}\right)n^2$

Probability $\psi(x)^2$

Barrier tunneling $T = e^{-2kL}$ $k = \sqrt{\frac{2m}{\hbar^2}\left(E_{pot} - E\right)}$

Binding Energy:

$\Delta E_{be} = \sum\left(mc^2\right) - Mc^2$

Disintegration Energy:

$Q = (\sum M_P c^2 - \sum M_d c^2)$

Energy Levels for H-Atom

$E_n = -\frac{13.6eV}{n^2}$

Probability of an electron in an H-atom, in the ground state, being found inside a sphere of radius r.

$p(r) = 1 - e^{-2x}(1 + 2x + 2x^2)$, where $x = r / a$

Magnetic Dipole Moment $\vec{\mu}_{orb} = -\frac{e}{2m}\vec{L}$ **where** $L = \frac{h}{2\pi}\sqrt{l(l+1)}$

z-component of angular momentum $L_z = m_l \frac{h}{2\pi}$ **Spin Angular Momentum** $S = \frac{h}{2\pi}\sqrt{s(s+1)}$

Radius of atomic nucleus $r = r_0 A^{1/3}$**, where** $r_0 = 1.2\ fm$

Radioactive Decay $N = N_0 e^{-\lambda t}$ **Decay Rate** $\Delta N/\Delta t = (N_0/\Delta t)\ e^{-\lambda t}$ **Half-life** $T_{1/2} = \frac{\ln 2}{\lambda} = \tau \ln 2$