Constants

$\sigma = 5.6703x10^{-8}\,\frac{W}{m^2K^4}$, h=6.626x10^{-34} J.s = 4.136x10^{-15} eV.s,
1eV=1.602x10^{-19} J, c=3x10^{8}m/s hc=1240 eV.nm,
m_e=9.11x10^{-31} kg = 0.511 MeV/c^2
e=-1.602x10^{-19} C

Interference and Diffraction

Young's double slit experiment

$$E_{tot} = (2A\cos\frac{\phi}{2})\sin(kr_1 - \omega t + \frac{\phi}{2})$$

$$\phi = k\delta\,,\;\; k = \frac{2\pi}{\lambda} \quad \delta = d\sin\theta\,,\;\; \sin\theta \approx \frac{y}{L}$$

$$\cos\frac{\phi}{2} = \pm 1\,,\;\; \phi = 2m\pi\,,\;\; \delta = m\lambda\,; \qquad \cos\frac{\phi}{2} = 0\,,\;\; \phi = (2m+1)\pi\,,\;\; \delta = (m+\frac{1}{2})\lambda$$

$$I(\theta) = I_0\cos^2(\frac{\phi}{2})$$

Thin film Interference

$\delta = 2nt$, Additional phase difference of $\frac{\pi}{2}$

$\phi = (2m+1)\pi$, $\phi = 2m\pi$

Diffraction

$$a\sin\theta = m\lambda\,, \qquad I(\theta) = I_0\left[\frac{\sin(\frac{\pi a}{\lambda}\sin\theta)}{(\frac{\pi a}{\lambda}\sin\theta)}\right]^2$$

$$I(\theta) = I_0\cos^2\frac{\varphi}{2}\left[\frac{\sin(\frac{\pi a}{\lambda}\sin\theta)}{(\frac{\pi a}{\lambda}\sin\theta)}\right]^2 \text{ where } \phi = \frac{2\pi d}{\lambda}\sin\theta$$

$$d\sin\theta = m\lambda\,, \qquad R = \frac{\lambda_{avg}}{\Delta\lambda} = mN$$

$$\sin\theta_1 = 1.22\frac{\lambda}{d}$$

Relativity

$$\Delta t = \gamma \Delta t_0, \qquad L = \frac{L_0}{\gamma}, \qquad \gamma = \frac{1}{\sqrt{1-\frac{u^2}{c^2}}}$$

$$x' = \gamma(x - ut), \qquad t' = \gamma(t - \frac{ux}{c^2})$$

$$v_x' = \frac{v_x - u}{1 - \frac{uv_x}{c^2}}, \qquad v_y' = \frac{v_y}{\gamma(1 - \frac{uv_x}{c^2})}, \qquad v_z' = \frac{v_z}{\gamma(1 - \frac{uv_x}{c^2})}$$

$$\vec{p} = \frac{m\vec{v}}{\sqrt{1-\frac{v^2}{c^2}}} = \gamma m \vec{v}, \qquad \vec{F} = \frac{d\vec{p}}{dt}$$

$$K = mc^2(\gamma - 1), \qquad E_R = mc^2, \qquad E = \gamma mc^2 = \sqrt{(pc)^2 + (mc^2)^2}$$

$$m = 0 \Rightarrow E = pc \Rightarrow p = \frac{E}{c}$$

Photons, Electrons and Atoms

$$P = \sigma T^4,$$

$$\lambda_m T = 2.898x10^{-3}\, m.K$$

$$I(\lambda) = \frac{2\pi hc^2 / \lambda^5}{e^{hc/\lambda kt} - 1},$$

$$E = hf = \frac{hc}{\lambda}, \qquad p = \frac{E}{c} = \frac{h}{\lambda},$$

$$K_{\max} = eV_0 = hf - \phi = \frac{hc}{\lambda} - \phi$$

$$\lambda' - \lambda_0 = \lambda_c(1 - \cos\phi), \quad \lambda_c = \frac{h}{mc} = 0.00243nm$$

$$L = mvr = n\hbar$$

$$r_n = \varepsilon_0 \frac{h^2 n^2}{\pi m e^2} = n^2 a_0, \qquad E_n = -\frac{1}{\varepsilon_0^2}\frac{me^4}{8h^2 n^2} = -\frac{E_0}{n^2}, \qquad E_0 = 13.6\ eV$$

$$E_{ion} = E_\infty - E_1 = 13.6\ eV$$

$$f = \frac{E_i - E_f}{h} = R_H\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right), \qquad n_i > n_f$$

$$R_H = \frac{mk_e^2 e^4}{4\pi c\hbar^3} \qquad = 1.097x10^7 m^{-1}$$