Chem. 524 Formula List (2/19/93)

Radiance: $B_\lambda = \frac{\partial^3 \Phi}{\partial \Omega \partial A_p \partial \lambda}$ $(W\,sr^{-1}\,cm^{-2}\,nm^{-1})$ Table 2-1

(sr) = solid angle subtending area $= r^2$; sphere $= 4\pi$(sr)

Population distribution: $n_i = n_t g_i e^{-E_i/kT} / [\sum_j g_j e^{-E_j/kT}]$ 2-14

Emission flux $\Phi_E = A_{ji}\, h\nu_{ji}\, n_j\, V$ 2-15

Black body $B_\nu^b = \frac{2h\nu^3}{c^2} \frac{1}{e^{h\nu/kT} - 1}$ (4-2, 4-3)

$B_\lambda^b = \frac{2hc^2}{\lambda^5} \frac{1}{e^{hc/\lambda kT} - 1} = \frac{c_1 \lambda^{-5}}{e^{c_2/\lambda T} - 1}$ $c_1 = 1.19 \times 10^{16}\, W cm^{-2} sr^{-1} nm^4$, $c_2 = 1.44 \times 10^7\, nm\, K$

$\lambda_m = c_2/4.9651\,T = \frac{2.87 \times 10^6}{T}$ (4-4, 4-5)

$B^b = \sigma T^4 = \int B_\lambda^b\, d\lambda$ $\sigma = 1.80 \times 10^{-12}\, W cm^{-2} sr^{-1} K^{-4}$

Index of refraction $n = \sqrt{K_d K_m} = c/v$ 3-2, 3

Snell's law $n_1 \sin\theta_1 = n_2 \sin\theta_2$ 3-5

reflection loss (1) $\rho = (n_2 - n_1/n_2 + n_1)^2$ 3-8

(angle θ) $= \frac{1}{2}\left[\frac{\sin^2(\theta_1 - \theta_2)}{\sin^2(\theta_1 + \theta_2)} + \frac{\tan^2(\theta_1 - \theta_2)}{\tan^2(\theta_1 + \theta_2)}\right]$ 3-9

critical angle $\theta_c = \sin^{-1}(n_2/n_1)$

Transmittance $T = \Phi/\Phi_0 = e^{-kb} = e^{-k'bc} = 10^{-abc} = e^{-\sigma bn}$ 3-12

E-M field: $\vec{E} = \vec{E}_m \sin[\omega t - kx + \phi_0]$ irrad: $E = c\varepsilon_0 |\vec{E}_m|^2/2$ 3-15,16

Mirrors: $1/s_1 + 1/s_2 = -2/R$ $m = -i/o$ 3-29

Lenses ("thin"): $1/s_1 + n/s_2' = n-1/R \Rightarrow \frac{1}{s_1} + \frac{1}{s_2} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$ 3-33,35

Image irrad: $E_i = (B_s \pi/4m^2)/(F/n)^2$ $(F/n) = s_1/D$ $\Omega = \frac{\pi}{4}/(F/n)^2$ 3-41, 43, 45

Fiber optic: $NA = \eta_0 \sin\theta_0 = (n_1^2 - n_2^2)^{1/2}$ $F/n = 1/(2\tan\theta_0)$ 3-46

Interference filter: $2d(n^2 - \sin^2\theta)^{1/2} = m\lambda = 2dn$ $[\theta = 0]$ 3-47,48

Prism: $D_a = d\theta/d\lambda = dn/d\lambda \; d\theta/dn$ 3-49

Grating: $d(\sin\alpha + \sin\beta) = m\lambda$ $\lambda_b = d\sin(2\theta_b)$, $\alpha = 0$ 3-50

$D_a = d\beta/d\lambda\,|_{\alpha = \text{const}} = \frac{|m|}{d\cos\beta} = \frac{\sin\alpha + \sin\beta}{\lambda\cos\beta}$, $D_l = f \cdot D_a$ 3-52

Monochromator $\beta = \theta + \phi$, $\alpha = \theta - \phi$: $m\lambda = 2d\sin\theta \cos\phi$ $R_l = (D_l)^{-1}$ 3-53

$s_g = R_d W$ $\Delta\lambda_s = 2s_g$ $\Delta\lambda_d = \frac{\lambda}{D_a W_D'}$ $W_D' = W_D \cos\beta$ 3-61,63,64

$R_{th} = \frac{W_D' |m|}{d\cos\beta} = |m|N$ $\Phi_0 = B_\lambda W H \Omega T_{op} (s_g = R_d W)$ 3-67,74