

RADIAÇÃO E ENERGIA SOLAR – EXAME 2014/2015

TABLE 12.2 Blackbody Radiation Functions

λT ($\mu\text{m} \cdot \text{K}$)	$F_{(0 \rightarrow \lambda)}$	$I_{\lambda, b}(\lambda, T)/\sigma T^5$ ($\mu\text{m} \cdot \text{K} \cdot \text{sr}$) ⁻¹	$\frac{I_{\lambda, b}(\lambda, T)}{I_{\lambda, b}(\lambda_{\text{max}}, T)}$
200	0.000000	0.375034×10^{-27}	0.000000
400	0.000000	0.490335×10^{-13}	0.000000
600	0.000000	0.104046×10^{-8}	0.000014
800	0.000016	0.991126×10^{-7}	0.001372
1,000	0.000321	0.118505×10^{-5}	0.016406
1,200	0.002134	0.523927×10^{-5}	0.072534
1,400	0.007790	0.134411×10^{-4}	0.186082
1,600	0.019718	0.249130	0.344904
1,800	0.039341	0.375568	0.519949
2,000	0.066728	0.493432	0.683123
2,200	0.100888	0.589649×10^{-4}	0.816329
2,400	0.140256	0.658866	0.912155
2,600	0.183120	0.701292	0.970891
2,800	0.227897	0.720239	0.997123
2,898	0.250108	0.722318×10^{-4}	1.000000
3,000	0.273232	0.720254×10^{-4}	0.997143
3,200	0.318102	0.705974	0.977373
3,400	0.361735	0.681544	0.943551
3,600	0.403607	0.650396	0.900429
3,800	0.443382	0.615225×10^{-4}	0.851737
4,000	0.480877	0.578064	0.800291
4,200	0.516014	0.540394	0.748139
4,400	0.548796	0.503253	0.696720
4,600	0.579280	0.467343	0.647004
4,800	0.607559	0.433109	0.599610
5,000	0.633747	0.400813	0.554898
5,200	0.658970	0.370580×10^{-4}	0.513043
5,400	0.680360	0.342445	0.474092
5,600	0.701046	0.316376	0.438002
5,800	0.720158	0.292301	0.404671
6,000	0.737818	0.270121	0.373965
6,200	0.754140	0.249723×10^{-4}	0.345724
6,400	0.769234	0.230985	0.319783
6,600	0.783199	0.213786	0.295973
6,800	0.796129	0.198008	0.274128
7,000	0.808109	0.183534	0.254090
7,200	0.819217	0.170256×10^{-4}	0.235708
7,400	0.829527	0.158073	0.218842
7,600	0.839102	0.146891	0.203360
7,800	0.848005	0.136621	0.189143
8,000	0.856288	0.127185	0.176079
8,500	0.874608	0.106772×10^{-4}	0.147819
9,000	0.890029	0.901463×10^{-5}	0.124801
9,500	0.903085	0.765338	0.105956
10,000	0.914199	0.653279×10^{-5}	0.090442
10,500	0.923710	0.560522	0.077600
11,000	0.931890	0.483321	0.066913
11,500	0.939959	0.418725	0.057970
12,000	0.945098	0.364394×10^{-5}	0.050448
13,000	0.955139	0.279457	0.038689
14,000	0.962898	0.217641	0.030131
15,000	0.969981	0.171866×10^{-5}	0.023794
16,000	0.973814	0.137429	0.019026
18,000	0.980860	0.908240×10^{-6}	0.012574
20,000	0.985602	0.623310	0.008629

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$$I_{\lambda,e}(\lambda, \theta, \phi) = \frac{dq}{dA_1 \cos \theta \cdot d\omega \cdot d\lambda}$$

$$E_\lambda(\lambda) = \int_0^{2\pi} \int_0^{\pi/2} I_{\lambda,e}(\lambda, \theta, \phi) \cos \theta \sin \theta \cdot d\theta \cdot d\phi$$

$$I_{\lambda,b}(\lambda, T) = \frac{2hc_o^2}{\lambda^5 [\exp(hc_o/\lambda k_B T) - 1]}$$

$$E_{cn} = \sigma T^4$$

$$\sigma = 5.670 \times 10^{-8} \text{ W/m}^2 \text{ K}^4$$

$$F_{0 \rightarrow \lambda} = \frac{\int_0^\lambda E_{\lambda, cn} d\lambda}{\sigma T^4} = f(\lambda T)$$

$$\varepsilon_{\lambda,\theta}(\lambda, \theta, \phi, T) \equiv \frac{I_{\lambda,e}(\lambda, \theta, \phi, T)}{I_{\lambda,b}(\lambda, T)}$$

$$\rho_\lambda(\lambda) \equiv \frac{G_{\lambda, \text{ref}}(\lambda)}{G_\lambda(\lambda)}$$

$$\tau_\lambda = \frac{G_{\lambda, \text{tr}}(\lambda)}{G_\lambda(\lambda)}$$

$$E_0 = (r_0/r)^2 = 1 + 0.033 \cos[(2\pi d_n/365)]$$

$$\delta = 23.45 \sin\left[\frac{360}{365}(d_n + 284)\right]$$

$$\omega_s = \cos^{-1}(-\tan \phi \tan \delta).$$

$$E_t = (0.000075 + 0.001868 \cos \Gamma - 0.032077 \sin \Gamma - 0.014615 \cos 2\Gamma - 0.04089 \sin 2\Gamma)(229.18).$$

$$\cos \psi = (\sin \alpha \sin \phi - \sin \delta) / \cos \alpha \cos \phi$$

$$\sin \psi = \cos \delta \sin \omega / \cos \alpha.$$

$$\cos \theta_z = \sin \delta \sin \phi + \cos \delta \cos \phi \cos \omega = \sin \alpha$$

$$\omega'_s = \min\{\cos^{-1}(-\tan \delta \tan \phi), \cos^{-1}[-\tan \delta \tan(\phi - \beta)]\}$$

$$\begin{aligned} \cos \theta &= (\sin \phi \cos \beta - \cos \phi \sin \beta \cos \gamma) \sin \delta \\ &+ (\cos \phi \cos \beta + \sin \phi \sin \beta \cos \gamma) \cos \delta \cos \omega \\ &+ \cos \delta \sin \beta \sin \gamma \sin \omega \end{aligned}$$

$$\cos \theta = \cos \beta \cos \theta_z + \sin \beta \sin \theta_z \cos(\psi - \gamma).$$

$$I_0 = I_{SC} E_0 (\sin \delta \sin \phi + \cos \delta \cos \phi \cos \omega_i).$$

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$$H_0 = \frac{24}{\pi} I_{SC} E_0 [(\pi/180)\omega_s(\sin \delta \sin \phi) + (\cos \delta \cos \phi \sin \omega_s)]$$

$$I_{0\beta\gamma} = I_{SC} E_0 [(\sin \phi \cos \beta - \cos \phi \sin \beta \cos \gamma) \sin \delta + (\cos \phi \cos \beta + \sin \phi \sin \beta \cos \gamma) \cos \delta \cos \omega_i + \cos \delta \sin \beta \sin \gamma \sin \omega_i],$$

$$H_{0\beta\gamma} = (12/\pi) I_{SC} E_0 (\cos \beta \sin \delta \sin \phi | \omega_{ss} - \omega_{sr} | \pi/180 - \sin \delta \cos \phi \sin \beta \cos \gamma | \omega_{ss} - \omega_{sr} | \pi/180 + \cos \phi \cos \delta \cos \beta | \sin \omega_{ss} - \sin \omega_{sr} | + \cos \delta \cos \gamma \sin \phi \sin \beta | \sin \omega_{ss} - \sin \omega_{sr} | + \cos \delta \sin \beta \sin \gamma | \cos \omega_{ss} - \cos \omega_{sr} |).$$

$$I_{n\lambda} = I_{0n\lambda} \exp(-k_\lambda m), \quad k_\lambda m = \sum_{i=1}^{i=j} k_{i\lambda} m_i, \quad k_{a\lambda} = \beta \lambda^{-\alpha}$$

$$\tau_R(\lambda) = 1,031 \times 0,00838 \lambda^{-\left(3,916+0,074\lambda+\frac{0,050}{\lambda}\right)}$$

$$\beta = (0,55)^{(3,912/Vis - 0,01162)} [0,02472(Vis - 5) + 1,132]$$

$$\tau_{g\lambda} = \exp[-1,41 k_{g\lambda} m_a / (1 + 118,93 k_{g\lambda} m_a)^{0,45}]$$

$$\tau_{wa\lambda} = \exp[-0,2385 k_{wa\lambda} w m_r / (1 + 20,07 k_{wa\lambda} w m_r)^{0,45}]$$

$$I_{b\lambda} = I_{0n\lambda} \cos(\theta_z) \tau_\lambda$$

$$T_e = \left[\frac{S_0(1 - \alpha_p)}{4\sigma} \right]^{\frac{1}{4}}, \quad \sigma T_a^4 = \frac{1}{4} (1 - \alpha_p) S_0 = \sigma T_e^4, \quad T_s = \left(\frac{2}{2 - \epsilon} \right)^{\frac{1}{4}} T_e$$

$$\sigma T_s^4 = \frac{1}{4} (1 - \alpha_p) S_0 + \sigma T_e^4 = 2\sigma T_e^4, \quad T_a = \left(\frac{1}{2 - \epsilon} \right)^{\frac{1}{4}} T_e = \left(\frac{1}{2} \right)^{\frac{1}{4}} T_s$$