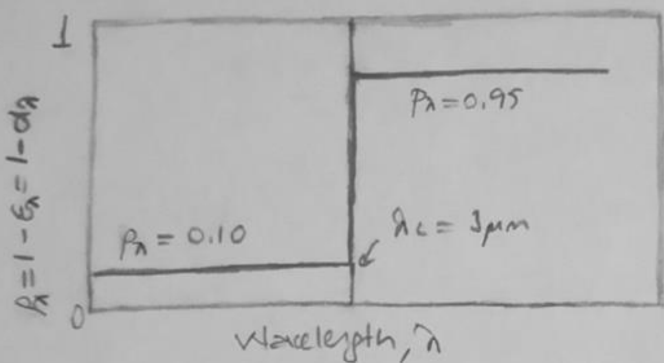
Table 3.6.1a Fraction of Blackbody Radiant Energy between Zero and λT for Even Increments of λT

λT, μm K	$f_{0-\lambda T}$	λT, μm K	$f_{0-\lambda T}$	λT, μm K	$f_{0-\lambda T}$
1,000	0.0003	4,500	0.5643	8,000	0.8562
1,100	0.0009	4,600	0.5793	8,100	0.8601
1,200	0.0021	4,700	0.5937	8,200	0.8639
1,300	0.0043	4,800	0.6075	8,300	0.8676
1,400	0.0077	4,900	0.6209	8,400	0.8711
1,500	0.0128	5,000	0.6337	8,500	0.8745
1,600	0.0197	5,100	0.6461	8,600	0.8778
1,700	0.0285	5,200	0.6579	8,700	0.8810
1,800	0.0393	5,300	0.6693	8,800	0.8841
1,900	0.0521	5,400	0.6803	8,900	0.8871
2,000	0.0667	5,500	0.6909	9,000	0.8899
2,100	0.0830	5,600	0.7010	9,100	0.8927
2,200	0.1009	5,700	0.7107	9,200	0.8954
2,300	0.1200	5,800	0.7201	9,300	0.8980
2,400	0.1402	5,900	0.7291	9,400	0.9005
2,500	0.1613	6,000	0.7378	9,500	0.9030
2,600	0.1831	6,100	0.7461	9,600	0.9054
2,700	0.2053	6,200	0.7541	9,700	0.9076
2,800	0.2279	6,300	0.7618	9,800	0.9099
2,900	0.2506	6,400	0.7692	9,900	0.9120
3,000	0.2732	6,500	0.7763	10,000	0.9141
3,100	0.2958	6,600	0.7831	11,000	0.9318
3,200	0.3181	6,700	0.7897	12,000	0.9450
3,300	0.3401	6,800	0.7961	13,000	0.9550
3,400	0.3617	6,900	0.8022	14,000	0.9628
3,500	0.3829	7,000	0.8080	15,000	0.9689
3,600	0.4036	7,100	0.8137	16,000	0.9737
3,700	0.4238	7,200	0.8191	17,000	0.9776
3,800	0.4434	7,300	0.8244	18,000	0.9807
3,900	0.4624	7,400	0.8295	19,000	0.9833
4,000	0.4809	7,500	0.8343	20,000	0.9855
4,100	0.4987	7,600	0.8390	30,000	0.9952
4,200	0.5160	7,700	0.8436	40,000	0.9978
4,300	0.5327	7,800	0.8479	50,000	0.9988
4,400	0.5488	7,900	0.8521	∞	1.

Example 4.8.1

For the surface shown in figure, calculate the absorptance for blackbody radiation from a source at 5777 K and the emittance at surface temperature of 150 and 500°C.



A hypothetical selective surface with the cut off wavelength at 3μm

Solution

The absorptance for radiation from a blackbody sorce at 5777 K is found with incident radiation $q_{\lambda,i}$ given by Planck's law.

For this problem, α_λ has two values, α_s in the short wavelengths below λ_c and α_L in the long wavelengths!

$$\alpha = \alpha_s f_{0-\lambda T} + \alpha_L (1 - f_{0-\lambda T})$$

where $f_{0-\lambda T}$ is the fraction of the incident blackbody radiation below the critical wavelength and is found at $\lambda T = 3 \times 5777 = 17{,}331$.

Therefore the absorptance is

$$\alpha = (1 - 0.10)(0.979) + (1 - 0.95)(1 - 0.979) = 0.88$$

The emittances at 150 and 500°C are found $\varepsilon = \sum_{j=1}^{n} \varepsilon_i \cdot \Delta f_i$ equation,

$$\varepsilon = \varepsilon_s f_{0-\lambda T} + \varepsilon_L (1 - f_{0-\lambda T})$$

where $f_{0-\lambda T}$ is now the fraction of the blackbody energy that is below the critical wavelength but at the surface temperature rather than the source temperature, as was used in calculating the absorptance. For a surface temperature of 150°C (423K), $\lambda T = 1269$ and $f_{0-\lambda T} = 0.004$. The emittance at 150°C is then

$$\varepsilon_{150} = (1 - 0.10)(0.004) + (1 - 0.95)(0.996) = 0.05$$

at a surface temperature of 500°C, $f_{0-\lambda T} = 0.124$ and the emittance at 500°C is

$$\varepsilon_{500} = (1 - 0.10)(0.124) + (1 - 0.95).(0.876) = 0.16$$

In practice, the wavelength dependence of ρ_λ does not approach the ideal curve of figure. Real selective surface do not have a well-defined critical wavelength λ_c or uniform properties in the short and long wavelength ranges. Value of emittance will be more sensitive to surface temperature than those of the ideal semigray surface of figure.