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ERRATA

THERMAL RADIATION HEAT TRANSFER

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NOTE: The recent update to the International System of Units has changed some values for constants used in Example Problems and Homework. These are updated in the Errata to use the latest SI values. The recently updated SI constant values are noted at the end of this Errata listing.

Page Correction

20 In Examples 1.2 and 1.2, the revised value of C_1 (see page 890, below) changes the results slightly.In Example 1.1, the first equation results in 2747 W/(m^2·μm·sr), and the final result is 8629 rather than 8627 W/(m^2·μm). In Example 1.2, replace the result of 0.256 x 10^8 with 0.259 x 10^8.

25 At end of paragraph preceding Eq. (1.29), replace the parenthetical expression with: (assuming *n* is independent of wavelength):

*Eq. (1.30) should read: $\lambda_{\max}T = C_3 = 2897.7720$ μm·K

*Eq. (1.31), replace the value of C_4 with 4.095 68 x 10^{-12}and in the line below, with 4.095 68 x 10^{-12}

26 *In Eq. (1.34) replace the value of σ with 5.670 374 419 x 10^{-8} (W/m^2·K). (This affects the value of σ shown in some later examples, but does not affect the results since usually rounded to at most 6 sig figs)

28 In Eqs. (1.39) and (1.40), make the dummy variable explicit by using the forms:

$$F_{0\to\lambda T} = \frac{2\pi C_1}{\sigma T^4}\int_0^{\lambda}\frac{d\lambda}{\lambda^5\left(e^{\frac{C_2}{\lambda T}}-1\right)} = \frac{2\pi C_1}{\sigma C_2^4}\int_{\zeta}^{\infty}\frac{\zeta^{*3}}{e^{\zeta^*}-1}\,d\zeta^* \qquad (1.39)$$

$$F_{0\to\lambda T} = 1-\frac{15}{\pi^4}\int_0^{\zeta}\frac{\zeta^{*3}}{e^{\zeta^*}-1}\,d\zeta^* \qquad (1.40)$$

30 Example 1.9: The result for the 2500 K blackbody should be 48.3 %.

34 In Example 1.10, the rounded result should be 0.0809.

44 For clarity, reword the paragraph starting with “We start the analysis…” with:

We start the analysis with the radiative intensity $I_\lambda(\theta,\phi)$ leaving surface element dA as in Figure 1.18a.. The projected area is formed by taking the area that the energy is leaving and projecting it normal to the direction of the radiation, $dA\cos\theta$.

To analyze the radiative exchange between two finite surfaces, we need to carry out integration over the entire area of each surface. For this, consider radiative energy leaving a small area element dA_1 and traveling in a nonparticipating medium as in Figure 1.18b. Assume that this energy is incident on a second small area element dA_2 on finite area A_2, at distance S_{12} from dA_1. The projected areas are formed by taking the area that the energy is passing through and projecting it normal to the direction of the radiation; therefore, $dA_1\cos\theta_1$ and $dA_2\cos\theta_2$ are the normal components of the infinitesimal areas along direction S_{12}. The elemental solid angle is centered about the direction of the radiant path and has its origin at dA. Using the definition of spectral intensity $I_{\lambda,1}$ as the rate of energy passing through dA_1 per unit projected area per unit solid angle and per unit wavelength interval, the energy $dQ_{\lambda,1}$ from dA passing through dA_1 in the direction of S_{12} is

47 Eq. (1.85): The upper limit of the integral should be λ, not ∞.

51 In Problem 1.11, the answer should be 0.809 h

53 Replace the existing photo of Johann Heinrich Lambert with this photo:

58-60 Figure 2.2 should be contiguous, and not split between separated pages. On page 58, Figure 2.2 caption, add "(Continued on Page 60)." On Page 60, in Figure 2.2, begin caption with "FIGURE 2.2 (Continued from Page 58): Pictorial descriptions….."

62-63 In Figure 2.4, change the cosine function to 0.850 cos(θ). Use this function in the solution of Example 3.4, and round the result to 3 significant figures to give a final result of 32,200 W/m^2.

64 The first equation on the page is missing minus signs, and should read:

$$\varepsilon\left(T_A\right)=0.1F_{0\to 2000}+0.4\left(F_{0\to 6000}-F_{0\to 2000}\right)+0.2\left(1-F_{0\to 6000}\right)=0.3275$$

In Example 2.5 the first equation should read:

$$\varepsilon\left(650\ \mathrm{K}\right)=0.90F_{0\to 2275}+\frac{1}{\sigma 650^4}\int_{3.5}^{9.5}\left(1.27917-0.10833\lambda\right)\frac{2\pi C_1}{\lambda^5\left(e^{C_2/650\lambda}-1\right)}d\lambda+0.25\left(1-F_{0\to 6175}\right)$$

65 Figure 2.7: Interchange $d\Omega_i$ and $d\Omega$ in parts (a) and (b).

Figure caption should now read:

> FIGURE 2.7: Equivalent ways of showing energy from dA_i that is incident on dA. (a) Incidence within solid angle $d\Omega$ having origin at dA_i; incidence within solid angle $d\Omega_i$ having origin at dA.

73 In the first equation in Example 2.7, all upper limits in the integrals should be ∞, not N (3 places). Also, due to the revised constants*, the final answer should read:

$$\alpha = 0.90 \times 0.32639 + 0.37832 + 0.25(1 - 0.88375) = 0.7015.$$

76 In Eq. (2.48), delete the double apstrophes on both sides.

91 Delete the figure at the top of the page. It is not part of the homework.

In Homework Problem 2.5, the answer to part (a) should be 0.764.

93 In Homework Problem 2.10, the answer should be 30.4 min.

99 Example 3.1: Answer for perpendicular compnent should be 0.299, and reflectivity for unpolarized incident intensity should be 0.251.

101 Example 3.3: The reference to the figure should be to Fig. 3.3b, not 3.2b.

105 Table 3.2. in the values for Normal Spectral Reflectivity for Aluminum, from Eq. (3.29), the values should be 0.916 and 0.979 instead of 0.883 and 0.970.

110-112 Example 3.4: On page 111, replace the equation with:

$$\alpha_n\left(T=250\text{ K}\right)=\frac{\varepsilon_n\left(T=500\text{ K}\right)}{\sqrt{2}}=\frac{\sqrt{1/2}\int_0^\infty \varepsilon_{\lambda,n}(T=500\text{ K})I_{\lambda,b}\left(500\text{ K}\right)d\lambda}{\int_0^\infty I_{\lambda,b}\left(500\text{ K}\right)d\lambda}$$

On page 112, replace the equation with

$$\varepsilon_n\left(T=500\text{ K}\right)=0.0348T\sqrt{r_{e,273}}=0.0348T\sqrt{r_{e,273}}\sqrt{\frac{273}{298}T}$$

$$=0.0348\sqrt{10\times10^{-6}}\sqrt{\frac{273}{298}}\times500=0.053$$

142 Equation above the Table: Replace q_{sol} with G_{sol}.

143 In Eq. (3.46), replace q_{sol} with G_{sol}.

In Example 3.6, replace "… in Figure 3.46…" with "… in Figure 3.50…"

Also, the upper limits in the two integrals should be ∞ and not the symbol ¥, as should the upper limits in two of the blackbody fractions in the two integral equations.

144 In first line, replace 15 μm with 1.5 μm

145 Example 3.7: The upper limits in the two integrals should be ∞. The result of the first equation should be 1150 W/m^2. The result of the second equation should be 68.3 W/m^2. The final result should be 1150-68 = 1082 W/m^2.

148 In HW Problem 3.1, the answers should be 0.9797 and 0.9405

149 In HW Problem 3.5, first line shouuld be "Show using Equation (3.8) that….."

In HW Problem 3.6, the Answers should be: 645 K; 0.0329; 1.28

HW Problem 3.8 should read:

3.8 Using Equation 3.25 with data for *n* and *k* from Table 3.2, find the hemispherical emissivity of aluminum and titanium at 298K at 0.484 and 8.06 μm.

Answer: $\varepsilon_{\lambda,Al}(\lambda = 0.484\mu m) = \underline{0.086}$; $\varepsilon_{\lambda,\mathrm{Al}}(\lambda = 8.06\ \mu\mathrm{m}) = 0.014$;
$\varepsilon_{\lambda,\mathrm{Ti}}(\lambda = 0.484\ \mu\mathrm{m}) = \underline{0.678;}$ $\varepsilon_{\lambda,\mathrm{Ti}}(\lambda = 8.06\ \mu\mathrm{m}) = \underline{0.043.}$

In HW 3.9, add "…when exposed to the sun." to the problem statement.

150 In HW 3.10, answers should be -8.1 and 65.4°C.

In HW 3.12, the second answer should be 1819 W.

174 Example 4.13: First equation should read:

$$A_1F_{1-2} + A_1F_{1-3} = A_1; \quad A_2F_{2-1} + A_2F_{2-3} = A_2; \quad A_3F_{3-1} + A_3F_{3-2} = A_3$$

274 Replace the equation and following text with:

$$t = \frac{\rho_M V c\left(1/\varepsilon_1 + 1/\varepsilon_2 - 1\right)}{A_1\sigma}\left[\frac{1}{4T_2^3}\ln\left|\frac{(T_F + T_2)}{(T_I + T_2)}\right| + \frac{1}{2T_2^3}\left(\tan^{-1}\frac{T_F}{T_2} - \tan^{-1}\frac{T_I}{T_2}\right)\right]$$

Substituting ρ_M = 975 kg/m^3, $V = \frac{1}{6}\pi(0.15)^3\,\mathrm{m}^3$, c = 4195 J/(kg · K), $\varepsilon_1 = \varepsilon_2 = 0.020$, $A_1 = \pi \cdot (0.15)^2$ m^2, $\sigma = 5.6704 \times 10^{-8}$ W/(m^2·K^4), T_2 = 294 K, T_I = 368 K, and T_F = 322 K gives t = 1.65 h to cool if energy losses were only by radiation. Conduction losses through the bottle neck and free molecular transfer by the low-density gas between the cylinders usually cause the cooling to be faster.

378 Eq. (8.82) should read:

$$\rho(\theta_i) = \frac{\rho_\perp(\theta_i) + \rho_\parallel(\theta_i)}{2} = \frac{1}{2}\left[\frac{\tan^2(\theta_i - \chi)}{\tan^2(\theta_i + \chi)} + \frac{\sin^2(\theta_i - \chi)}{\sin^2(\theta_i + \chi)}\right]$$
$$= \frac{1}{2}\frac{\sin^2(\theta_i - \chi)}{\sin^2(\theta_i + \chi)}\left[1 + \frac{\cos^2(\theta_i + \chi)}{\cos^2(\theta_i - \chi)}\right]$$

384 Eq. (8.111) should read:

$$\epsilon_{II} = \mathrm{Im}(\chi_e) = \frac{\omega_p^2\zeta\omega}{\left(\omega_0^2 - \omega^2\right)^2 + \zeta^2\omega^2}$$

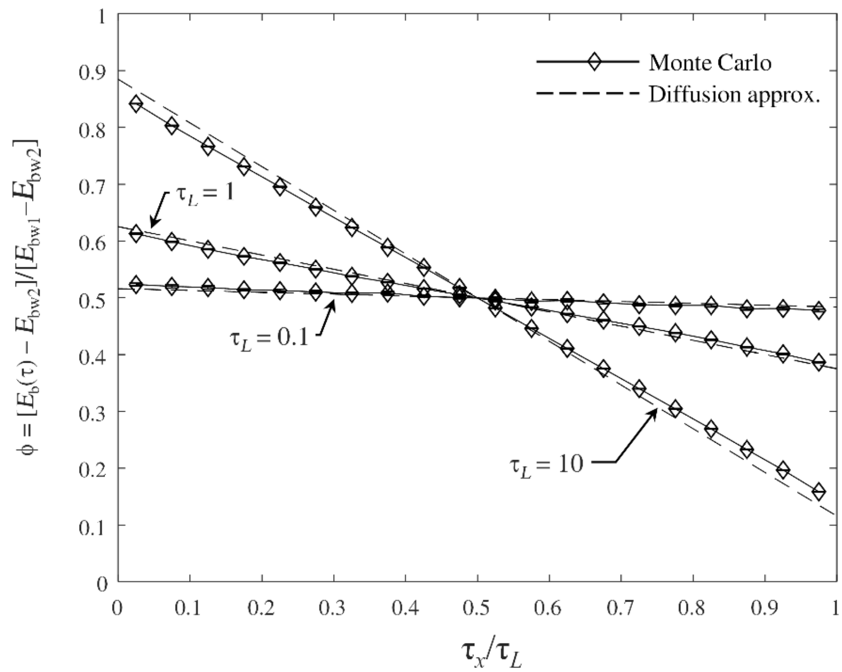
386 Eq. (8.118) The zeta (ζ) should be tau (τ).

389 Replace the existing photo of Maurice Paul Auguste Charles Fabry with this photo:

407	Figure 9.11	In units on vertical axis, replace *mol* with *kmol*.
415	Example 9.1	The first line of the second paragraph should read: Relations from the exponential wide-band model for α, β, and ω, and the transition (−1, 0, 1) are used. (See the footnote for the 9.4 μm band in Table 9.2).
470	First line of text:	Replace $\pm\,\infty$ with $\pm\,1$.
644	Section 14.2.2	Replace all β^{k} with $\hat{u}^{k}$

668 In Figure 14.11, in the trapezoid for Ω, switch the “yes” and “no” labels on the output arrows. In the bottom trapezoid, replace “$\mu > 1$?” with “$\mu > 0$?”.

Replace Figure 14.12 with the figure below:



686 Line after Eq. (15.5): replace $\vartheta(0) = 0$ with $\vartheta(0) = 1$.

888* The speed of light, c_o, should read $c_o = 2.997\ 924\ 58 \times 10^8$ m/s

The reduced Planck's constant should read $\hbar = h/2\pi = 1.054\ 571\ 817 \times 10^{-34}$ J$\cdot$s

The value for the Boltzmann constant should read $k = 1.380\ 649 \times 10^{-23}$ J/K

The value for the Classical electron radius should read:

$2.817\ 940\ 3262(\pm 13) \times 10^{-15}$ m

The value for the electron volt should read:

$1 \text{ eV} = 1.602\ 176\ 634 \times 10^{-19}$ J

890* The value of the radiation constant C_1 in SI should read

$C_1 = 0.595\ 521\ 49 \times 10^8$ W$\cdot\mu$m^4/(m$^2\cdot$sr)

$C_1 = 0.595\ 521\ 49 \times 10^{-16}$ W$\cdot$m^2/sr

The value of the radiation constant C_3 in SI should read

$C_3 = 2{,}897.7720$ μm$\cdot$K (note unit change from m to μm)

$C_3 = 0.002\ 897\ 7720\ m{\cdot}K$

The value of the Stefan-Boltzmann constant should read

$5.670\ 374\ 419 \times 10^{-8}\ (W/m^2{\cdot}K)$

Source: Should read Tiesinga et al., 2021.

**Most of these changes result from the recent fundamental revision in the International System of Units. See Appendix R in the on-line Appendices at:*

http://www.thermalradiation.net/appendix.html

or the video at

http://www.thermalradiation.net/videos.html