Radiation Assignment 1

1. A furnace that has a 25-cm × 25-cm glass window can be considered to be a blackbody at 1200 K. If the transmissivity of the glass is 0.7 for radiation at wavelengths less than 3 μm and zero for radiation at wavelengths greater than 3 μm, determine the fraction and the rate of radiation coming from the furnace and transmitted through the window.

2. The emissivity of a surface coated with aluminum oxide can be approximated to be 0.2 for radiation at wavelengths less than 5 μm and 0.9 for radiation at wavelengths greater than 5 μm. Determine the average emissivity of this surface at (*a*) 5800 K and (*b*) 300 K. What can you say about the absorptivity of this surface for radiation coming from sources at 5800 K and 300 K? *Answers:* (*a*) 0.203, (*b*) 0.89

3. The variation of the spectral transmissivity of a 0.6-cm-thick glass window is as given in Fig. P21–49. Determine the average transmissivity of this window for solar radiation ($T \approx$ 5800 K) and radiation coming from surfaces at room temperature ($T \approx$ 300 K). Also, determine the amount of solar radiation transmitted through the window for incident solar radiation of 650 W/m^2.
Answers: 0.848, 0.00015, 551.1 W/m^2

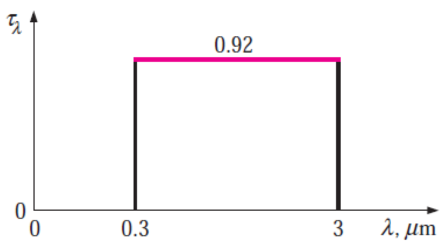
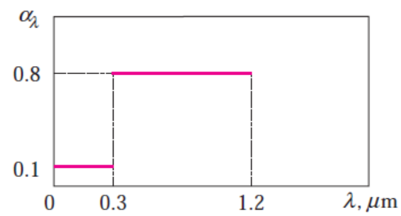


FIGURE P21–49

6. The spectral absorptivity of an opaque surface is as shown on the graph. Determine the absorptivity of the surface for radiation emitted by a source at (*a*) 1000 K and (*b*) 3000 K.



7. The surface in Prob. ~~21–67~~ 6 receives solar radiation at a rate of 820 W/m^2. Determine the solar absorptivity of the surface and the rate of absorption of solar radiation.

8. The spectral transmissivity of a glass cover used in a solar collector is given as

$$\tau_1 = 0 \quad \text{for} \quad \lambda < 0.3\ \mu\text{m}$$
$$\tau_2 = 0.9 \quad \text{for} \quad 0.3 < \lambda < 3\ \mu\text{m}$$
$$\tau_3 = 0 \quad \text{for} \quad \lambda > 3\ \mu\text{m}$$

Solar radiation is incident at a rate of 950 W/m^2, and the absorber plate, which can be considered to be black, is maintained at 340 K by the cooling water. Determine (*a*) the solar flux incident on the absorber plate; (*b*) the transmissivity of the glass cover for radiation emitted by the absorber plate; and (*c*) the rate of heat transfer to the cooling water if the glass cover temperature is also 340 K.

Problems from Incropera & Dewitt

4. A *small*, solid metallic sphere has an opaque, diffuse coating for which $\alpha_\lambda = 0.8$ for $\lambda \leq 5\ \mu$m and $\alpha_\lambda = 0.1$ for $\lambda > 5\ \mu$m. The sphere, which is initially at a uniform temperature of 300 K, is inserted into a *large* furnace whose walls are at 1200 K. Determine the total, hemispherical absorptivity and emissivity of the coating for the initial condition and for the final, steady-state condition.

5. The emission of radiation from a surface can be approximated as a blackbody radiation at T = 1000 K.
(*a*) What fraction of the total energy emitted is below $\lambda = 5\ \mu$m?
(*b*) What is the wavelength below which the emission is 10.5 percent of the total emission at 1000 K?
(*c*) What is the wavelength at which the maximum spectral emission occurs at T = 1000 K?