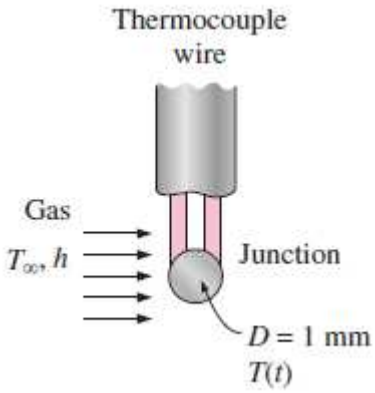
2° Lista de Exercícios

1)

The temperature of a gas stream is to be measured by a thermocouple whose junction can be approximated as a 1-mm-diameter sphere, as shown in Fig. 4–9. The properties of the junction are $k = 35$ W/m · °C, $\rho = 8500$ kg/m^3, and $C_p = 320$ J/kg · °C, and the convection heat transfer coefficient between the junction and the gas is $h = 210$ W/m^2 · °C. Determine how long it will take for the thermocouple to read 99 percent of the initial temperature difference.

R:10 s



2)

A person is found dead at 5 PM in a room whose temperature is 20°C. The temperature of the body is measured to be 25°C when found, and the heat transfer coefficient is estimated to be $h = 8$ W/m^2 · °C. Modeling the body as a 30-cm-diameter, 1.70-m-long cylinder, estimate the time of death of that person (Fig. 4–10).

OBS: Utilize o Método da Capacitância Global, mesmo o Bi sendo maior que 0.1.
R: 12.2 h

FIGURE 4–10

3)

An ordinary egg can be approximated as a 5-cm-diameter sphere (Fig. 4–19). The egg is initially at a uniform temperature of 5°C and is dropped into boiling water at 95°C. Taking the convection heat transfer coefficient to be $h = 1200\ \text{W/m}^2 \cdot {}^\circ\text{C}$, determine how long it will take for the center of the egg to reach 70°C.

Properties The water content of eggs is about 74 percent, and thus the thermal conductivity and diffusivity of eggs can be approximated by those of water at the average temperature of $(5 + 70)/2 = 37.5^\circ\text{C}$; $k = 0.627\ \text{W/m} \cdot {}^\circ\text{C}$ and $\alpha = k/\rho C_p = 0.151 \times 10^{-6}\ \text{m}^2/\text{s}$ (Table A-9).

R: 14.4 min

4)

A thick wood slab ($k = 0.17\ \text{W/m} \cdot {}^\circ\text{C}$ and $\alpha = 1.28 \times 10^{-7}\ \text{m}^2/\text{s}$) that is initially at a uniform temperature of 25°C is exposed to hot gases at 550°C for a period of 5 minutes. The heat transfer coefficient between the gases and the wood slab is $35\ \text{W/m}^2 \cdot {}^\circ\text{C}$. If the ignition temperature of the wood is 450°C, determine if the wood will ignite.

R: $T(x,t) = 356^\circ\text{C}$**, which is less than the ignition temperature of 450°C. Therefore, the wood will not ignite.**

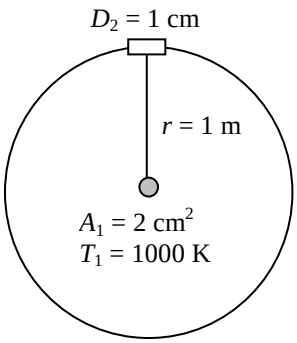
5)

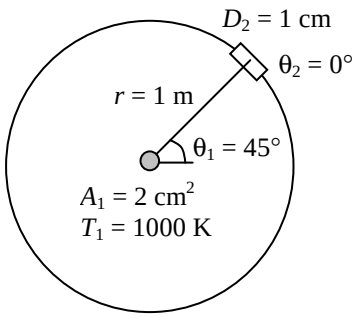
It is desired that the radiation energy emitted by a light source reach a maximum in the blue range ($\lambda = 0.47\ \mu\text{m}$). Determine the temperature of this light source and the fraction of radiation it emits in the visible range ($\lambda = 0.40\text{–}0.76\ \mu\text{m}$).

R: (43.7%)

6)

A small circular surface of area $A_1 = 2\ \text{cm}^2$ located at the center of a 2-m-diameter sphere emits radiation as a blackbody at $T_1 = 1000$ K. Determine the rate at which radiation energy is streaming through a $D_2 = 1$-cm-diameter hole located (*a*) on top of the sphere directly above A_1 and (*b*) on the side of sphere such that the line that connects the centers of A_1 and A_2 makes 45° with surface A_1.





R: a) $= 2.835 \times 10^{-4}$ **W**

b) $= 2.005 \times 10^{-4}$ **W**

7) The variation of the spectral transmissivity of a 0.6-cm-thick glass window is as given in Figure P11–49. 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.

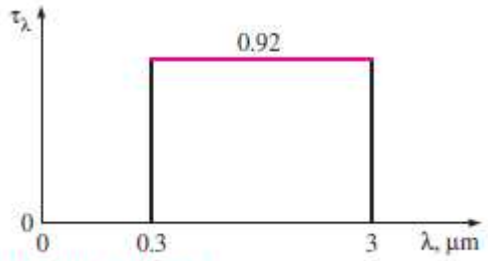


FIGURE P11–49

R: 0.848 , 0.00015 , 551 W/m^2

8) This experiment is conducted to determine the emissivity of a certain material. A long cylindrical rod of diameter $D_1 = 0.01$ m is coated with this new material and is placed in an evacuated long cylindrical enclosure of diameter $D_2 = 0.1$ m and emissivity $\varepsilon_2 = 0.95$, which is cooled externally and maintained at a temperature of 200 K at all times. The rod is heated by passing electric current through it. When steady operating conditions are reached, it is observed that the rod is dissipating electric power at a rate of 8 W per unit of its length and its surface temperature is 500 K. Based on these measurements, determine the emissivity of the coating on the rod.

R= 0.074