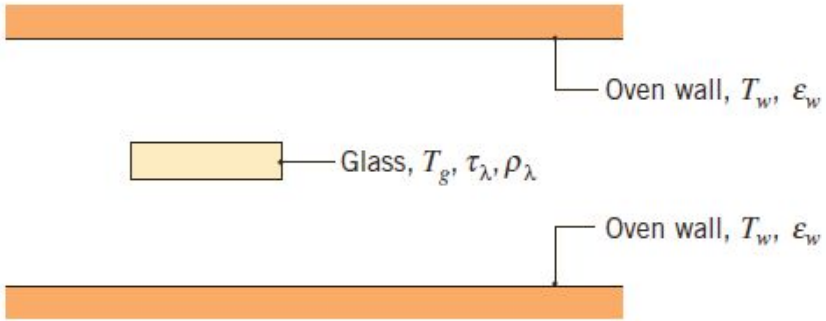
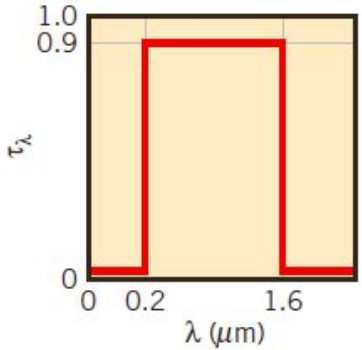
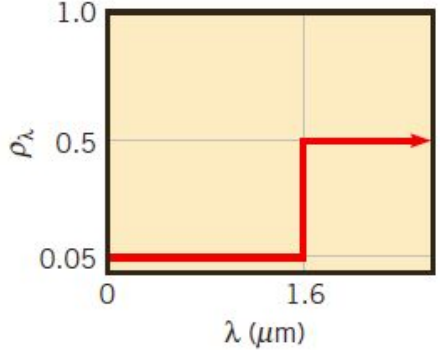
12.73 A special diffuse glass with prescribed spectral radiative properties is heated in a large oven. The walls of the oven are lined with a diffuse, gray refractory brick having an emissivity of 0.75 and are maintained at $T_w = 1800$ K. Consider conditions for which the glass temperature is $T_g = 750$ K.

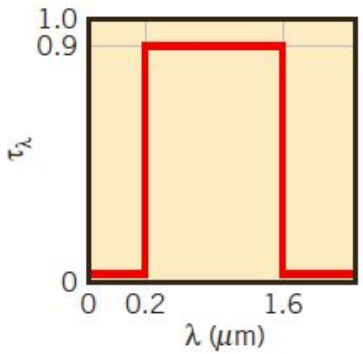


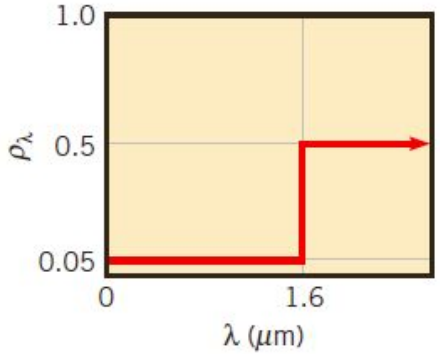




(a) What are the total transmissivity τ, the total reflectivity ρ, and the total emissivity ε of the glass?

(b) What is the net radiative heat flux, $q''_{\text{net,in}}$ (W/m^2), to the glass?





1800*0.2 = 360

1800*1.6 = 2880

λT ($\mu m \cdot K$)	$F_{(0 \to \lambda)}$
200	0.000000
400	0.000000
600	0.000000
2,898	0.250108

$$\tau = \frac{\int_0^\infty G_{\lambda,tr}(\lambda)\, d\lambda}{\int_0^\infty G_\lambda(\lambda)\, d\lambda} = \frac{\int_0^\infty \tau_\lambda(\lambda) G_\lambda(\lambda)\, d\lambda}{\int_0^\infty G_\lambda(\lambda)\, d\lambda}$$

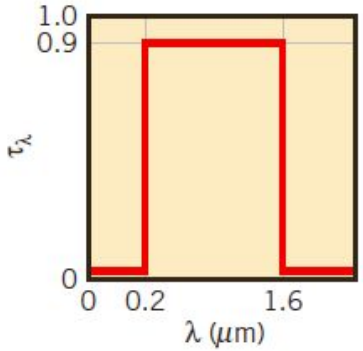
$\tau = \tau_\lambda(0.2\text{-}1.6) * (F(1.6) - F(0.2)) = 0.2251$

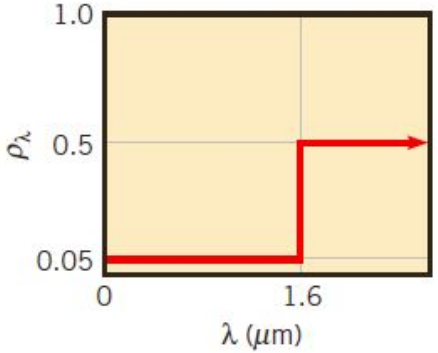
$$\rho = \frac{\int_0^\infty \rho_\lambda(\lambda) G_\lambda(\lambda)\, d\lambda}{\int_0^\infty G_\lambda(\lambda)\, d\lambda}$$

$\rho = \rho_\lambda(1.6)*F(1.6) + \rho_\lambda(1.6+) * (1-F(1.6)) = 0.3875$

$$\rho + \alpha + \tau = 1$$

$\alpha = 0.3875$





$$\varepsilon(T) = \frac{\int_0^\infty \varepsilon_\lambda(\lambda, T) E_{\lambda,b}(\lambda, T)\, d\lambda}{E_b(T)}$$

750*0.2 = 150

750*1.6 = 1200

$\alpha_\lambda = \varepsilon_\lambda$

α_λ (0-0.2) = 0.95

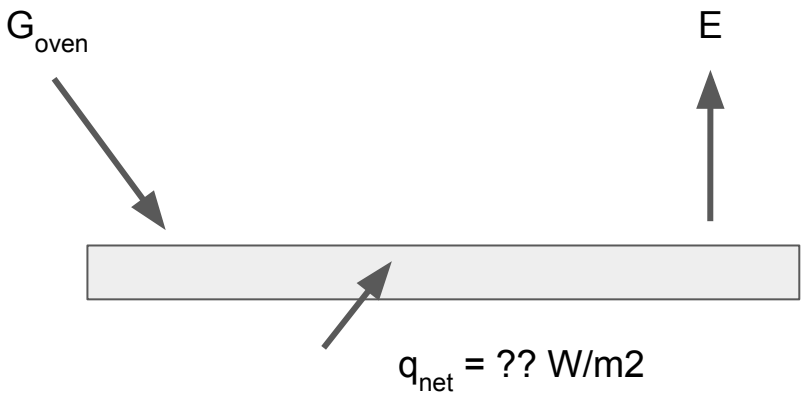
α_λ (0.2-1.6) = 0.1

α_λ (1.6+) = 0.5

$$\rho_\lambda + \alpha_\lambda + \tau_\lambda = 1$$

λT (μm · K)	$F_{(0\rightarrow\lambda)}$
200	0.000000
1,200	0.002134

$\varepsilon = \varepsilon_\lambda$(0.2-1.6) * (F(1.6) - F(0.2)) + ε_λ(1.6+) * (1-F(1.6))= 0.499



Irradiation absorbed

$\alpha_{glass} G = \alpha_{glass} \varepsilon_{oven} \sigma T_{oven}^{4} = 1.730e+5$ W/m2

Emissive power

$E = \varepsilon_{glass} \sigma T_{glass}^{4} = 8.955e+3$ W/m2

$\alpha G - E - q_{net} = 0$

$q_{net} = \alpha G - E = 1.64e+5$ W/m2