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## SOLUTIONS MANUAL

### CHAPTER 1

1. The energy contained in a volume  $dV$  is

$$U(\mathbf{r}, T)dV = U(\mathbf{r}, T) \cdot d\mathbf{r} \sin\theta d\theta d\phi$$

when the geometry is that shown in the figure. The energy from this source that emerges through a hole of area  $dA$  is

$$dE(\mathbf{r}, T) = U(\mathbf{r}, T)dV \frac{d\Omega \cos\theta}{4\pi^2}$$

The total energy emitted is

$$\begin{aligned} dE(\mathbf{r}, T) &= \int_{\Omega} \int_{\Omega'} d\Omega' \int_{\Omega''} d\Omega'' U(\mathbf{r}, T) \sin\theta \cos\theta \frac{d\Omega}{4\pi^2} \\ &= \frac{dA}{4\pi} \int_{\Omega} U(\mathbf{r}, T) \int_{\Omega'} d\Omega' \sin\theta \cos\theta \\ &= \frac{1}{4} dA U(\mathbf{r}, T) \end{aligned}$$

By definition of the emissivity, this is equal to  $\epsilon A dA$ . Hence

$$E(\mathbf{r}, T) = \frac{\epsilon}{4} U(\mathbf{r}, T)$$

2. We have

$$w(\mathbf{r}, T) = U(\mathbf{r}, T) \frac{dw}{dV} \frac{dV}{d\Omega} = U \frac{dw}{d\Omega} \frac{c}{2\pi^2} \frac{1}{\omega^2 - 1}$$

This density will be maximal when  $dw(\mathbf{r}, T)/d\omega = 0$ . What we need is

$$\frac{d}{d\omega} \left( \frac{1}{\omega^2 - 1} \right) = \left( -\frac{1}{\omega^2} \right) \left( \frac{dw}{d\omega} \right) \frac{1}{\omega^2 - 1} = 0$$

Where  $A = hc/\lambda T$ . The above implies that with  $x = A/\lambda$ , we must have

$$5 - x = 5x^4$$

A solution of this is  $x = 4.965$  so that

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