Environmental Science, Solutions Chapter 3

3.1

With the equation

$$(1 - a)\frac{S}{4} = f\sigma T^4$$

we get

$$1 - a = \frac{4 \cdot 0.61 \cdot 5.671 \cdot 10^{-8} \cdot 298^4}{1367} \Rightarrow a = 1 - 0.798 \approx 0.20$$

Answer: a = 0.20

3.2

With the equation

$$(1 - a)\frac{S}{4} = f\sigma T^4$$

we get

$$S = \frac{4f\sigma T^4}{1 - a} = \frac{4 \cdot 0.61 \cdot 5.671 \cdot 10^{-8} \cdot 288^4}{1 - 0.30} \text{ W/m}^2 \approx 1.4 \text{ kW/m}^2$$

Answer: 1.4 kW/m²

3.3

With $f_1\sigma T_1^4 = constant = f_2\sigma T_2^4$ we get

$$T_2 = T_1\left(\frac{f_1}{f_2}\right)^{1/4} = 288\left(\frac{0.61}{0.65}\right)^{1/4} \text{ K} \approx 280 \text{ K}.$$

Answer: 280 K

3.4

With $I = I_0 e^{-\mu x}$ we get

$$I = 10e^{-0.23 \cdot 85 \cdot 10^{-2}} = 10 \cdot 0.822 \text{ W/m}^2 \approx 8.2 \text{ W/m}^2.$$

Answer: 8.2 W/m²

3.5

With $I = I_0 e^{\mu x}$ we get

$$6.2 = 10e^{-\mu \cdot 15 \cdot 10^{-2}} \Rightarrow \ln\left(\frac{6.2}{10}\right) = -\mu \cdot 15 \cdot 10^{-2} \Rightarrow \mu = -\frac{\ln 0.62}{15 \cdot 10^{-2}} \text{ m}^{-1} \approx 3.2 \text{ m}^{-1}$$

Answer: 3.2 m⁻¹

3.6

With $\Delta I = \Delta t \sigma T^4$ we get

$$\Delta I = (0.61 - 0.60) \cdot 5.671 \cdot 10^{-8} \cdot 287.9^4 \ \text{W/m}^2 \approx 3.9 \ \text{W/m}^2$$

Answer: 3.9 W/m²

3.7

With $\Delta T = G\Delta I$ we get

$$4.5 = G \cdot 18 \Rightarrow G = \frac{4.5}{18} \ \text{K/Wm}^{-2} = 0.25 \ \text{K/Wm}^{-2}$$

Answer: 0.25 K/Wm^{-2}