## SOLUTION

**TQ2 [10 points]**

**2.1** The solar radiation intensity ( $I_T$) received on Earth is:

$$I_T = \frac{P_s}{4\pi r_{s-t}^2} = \sigma T_s^4 \bullet \left(\frac{R_s}{r_{s-t}}\right)^2 \qquad \text{[1 point]}$$

with $P_s = 4\pi\sigma R_s^2 T_s^4$ .

Also, Earth would absorb energy at this rate:

$$P_{abs} = I_T \pi R_t^2 = \pi\sigma T_s^4 \bullet \left(\frac{R_s \bullet R_t}{r_{s-t}}\right)^2$$

With $R_t = 6.4\times10^6 m$ as the radius of the planet "disk". [1 point]

Then, by thermal equilibrium, the absorbed radiation would be radiated over the planet's surface:

$$P_{abs} = P_{rad}$$

With

$$P_{rad} = 4\pi\sigma R_t^2 T_t^4$$

$$\pi\sigma T_s^4 \bullet \left(\frac{R_s \bullet R_t}{r_{s-t}}\right)^2 = 4\pi\sigma R_t^2 T_t^4 \qquad \text{[1 point]}$$

$$T_t = T_s \cdot \left(\frac{R_s}{2\, r_{s-t}}\right)^{\frac{1}{2}} = 278.58\ K = 5.43\ °C \qquad \text{[1 point]}$$

This would be very cold but still viable to harbor life.

**2.2** The Earth's absorbed radiation, considering the albedo, is:

$$P'_{abs} = 0.7 \cdot \pi\sigma T_s^4 \bullet \left(\frac{R_s \bullet R_t}{r_{s-t}}\right)^2 \qquad \text{[1 point]}$$

$$T'_T = T_s\,(0.7)^{\frac{1}{4}} \bullet \left(\frac{R_s}{2\, r_{s-t}}\right)^{\frac{1}{2}} = 254.81\ K = -18.34\ °C \qquad \text{[1 point]}$$

**2.3** If Earth reabsorbs 58% of the 70% re emitted energy, then:

$$T''_T = T_s\,[0.7 + (0.58 \cdot 0.7)]^{\frac{1}{4}} \bullet \left(\frac{R_s}{2\, r_{s-t}}\right)^{\frac{1}{2}} = 285.68\ K = 12.53\ °C \qquad \text{[4 points]}$$