# Sample Calculations Wx 365

Stefan-Boltzmann Law

$$E^* = \sigma T^4$$

If one object is <u>twice</u> as hot as another object, how many times more energy does it emit?

$$E^*_{cool} = \sigma T^4_{cool\ object}$$

$$E^*_{warm} = \sigma T^4_{warm\ object}$$

$$T_{warm\ object} = 2 \cdot T_{cool\ object}$$

$$E^*_{warm} = \sigma T^4_{warm\ object} = \sigma \left(2 \cdot T_{cool\ object}\right)^4$$

$$= \sigma \cdot 2^4 \cdot T^4_{cool\ object} = \sigma \cdot 16 \cdot T^4_{cool\ object}$$

$$E^*_{warm} = 16 \left(\sigma T^4_{cool\ object}\right) = 16 \cdot E^*_{cool\ object}$$

→ **16 times = $2^4$ times more energy**

How many times more energy (per unit area) does the sun emit than the earth?

$T_{sun} \simeq 6000\,K$

$T_{earth} \simeq 300\,K$

$$300\,K \overline{)6000\,K}\ 20$$

Sun is 20 times hotter than earth.

Sun emits $20^4$ times more energy!

$20^4 = 160{,}000$ times more per square meter of sfc area!!

# Wien's Law

$$\lambda_{max} = \frac{2897\,\mu m \cdot K}{T}$$

Remember, if given a temperature in °C, must convert to K before using this equation!

Say $T = 20°C \longrightarrow T \cong 20°C + 273K$

$$\cong 293K$$

$$\lambda_{max} = \frac{2897\,\mu m \cdot \cancel{K}}{293\cancel{K}} = \boxed{9.88\,\mu m}$$

$$\lambda_{max} = \frac{2897\,\mu m \cdot K}{T} \Longrightarrow T \cdot \lambda_{max} = 2897\,\mu m \cdot K$$

$$\Longrightarrow T = \frac{2897\,\mu m \cdot K}{\lambda_{max}}$$

let's say we measure the maximum amount of energy coming from the sun at 0.5082 μm. What is the temperature of the sun?

$$T = \frac{2897\ \mu m \cdot K}{0.5082\ \mu m} = \boxed{5700K}$$

# Greenhouse Effect

$T_{sun} \simeq 6000K$

$$\lambda_{max(sun)} = \frac{2897 \mu m K}{T_{sun}} \simeq \frac{3000 \mu m K}{6000 K}$$

$$\simeq \boxed{0.5 \mu m}$$

$T_{earth} \simeq 300K$

$$\lambda_{max(earth)} = \frac{2897 \mu m K}{T_{earth}} \simeq \frac{3000 \mu m K}{300 K}$$

$$\simeq \boxed{10 \mu m}$$