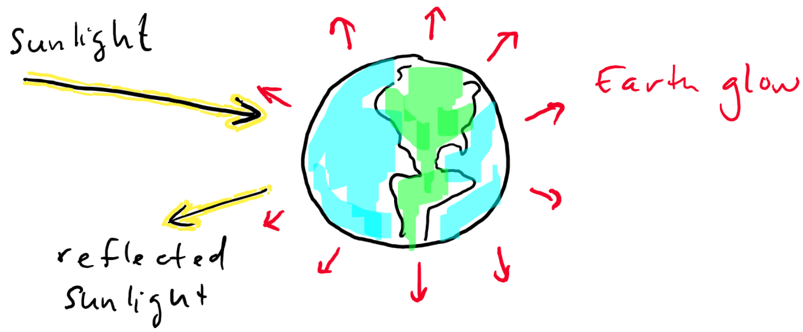
The **Stefan-Boltzmann law** states that the intensity of light from a blackbody object will be

$$I = \sigma T^4 \quad (1)$$

where σ is the Stefan-Boltzmann constant, which has dimeensions of intensity per T^4, and has a value of $\sim 5.7 \times 10^{-8} \frac{\text{J}}{\text{s}\cdot\text{m}^2\text{K}^4}$.



1 Climate modeling

For the Earth, we know the spectral distribution of incoming light and outgoing light, so we can construct an energy flow diagram.

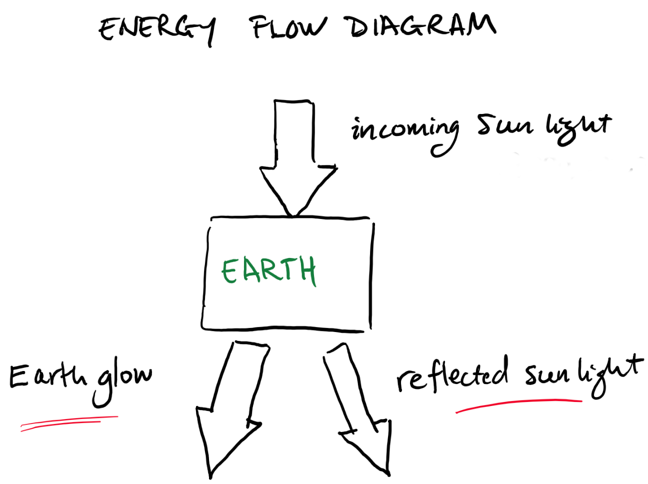


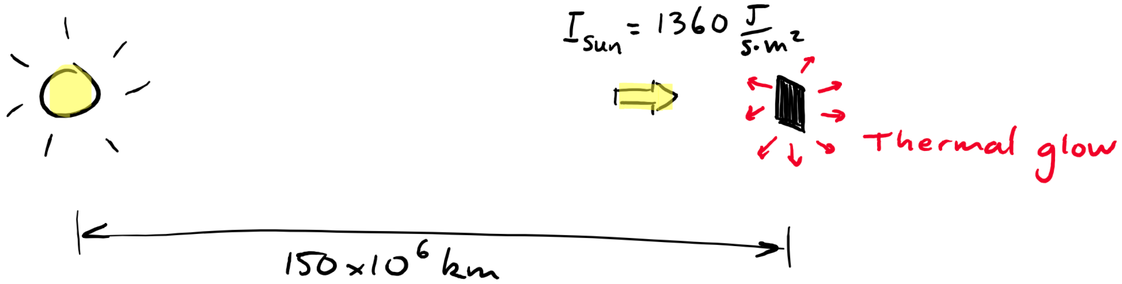
Figure 1: For T_{Earth} to be stable, the rate of energy out must be equal to the rate of energy in.

To a first order approximation, this is *all* the energy entering or leaving the Earth.

Other ways the Earth gains energy?	**Other ways the Earth loses energy?**
starlight	radio waves emitted
tidal forces $\rightarrow$ friction	
decay of radioactive elements in earth	
internal equilibration with core	

2 The temperature of objects in space

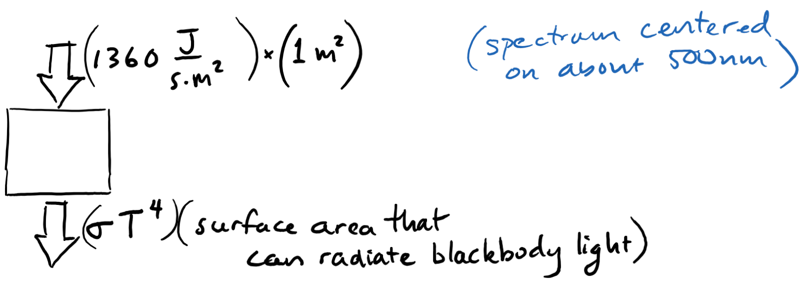
2.1 Example 1: A black metal panel



A thin sheet of black metal has dimension 1 m$\times$1 m$\times$0.001 m. It is facing normal to the Sun, absorbing energy at a rate of 1360 J/s from the Sun.

The sheet of metal has reached a stable temperature. What is that temperature?

Solution First draw an energy flow diagram.



We have a stable temperature, therefore

$$\left[1360\frac{\text{J}}{\text{s}\cdot\text{m}^2}\right][1\text{ m}^2] = \sigma T^4[2\text{ m}^2] \tag{2}$$

$$T^4 = \frac{\left[1360\frac{\text{J}}{\text{s}}\right]}{\left[5.7\times10^{-8}\frac{\text{J}}{\text{s}\cdot\text{m}^2\text{K}^4}\right][2\text{ m}^2]} \tag{3}$$

$$\approx \frac{1360}{11\times10^{-8}}\text{ K}^4 \tag{4}$$

$$\approx 120\times10^{8}\text{ K}^4 \tag{5}$$

$$T \approx 3.3\times10^{2}\text{ K} = 330\text{ K} \tag{6}$$

So it's not safe to be in a black box in space without air conditioning, or at least a shade umbrella. (Fun problem: how effective would a black shade umbrella be?)

But sadly, it's also not hot enough to cook poultry to a safe internal temperature. But perhaps cosmic radiation would be enough to sterilize food? Or maybe its simplest to cook your food before launching it into orbit...

Or maybe you can paint your capsule grey?