1 Planting Ideas for Your Term Project

Read `https://paradigms.oregonstate.edu/activity/722` carefully and start thinking of ideas for your term project. Be on the look-out for examples of rich-context problems in lecture notes and homework questions. [*This problem is not graded*].

2 Two-layer model for estimating the Earth's temperature

Two layers of plexiglass are surrounding the Earth. One layer is 5 km above sea level, the other layer is 10 km above sea level. These plexiglass layers have replaced the gaseous atmosphere. Both layers of plexiglass are transparent to the solar spectrum (wavelengths centered around 500 nm), but fully absorb the thermal radiation emitted from the surface of the Earth. The surface of the Earth absorbs 70% of the incident sunlight and reflects the rest. Assume that the Earth distributes the absorbed solar energy uniformly across its spherical surface, therefore, it has a uniform temperature, T_{surf}. Every part of this system is in steady state, meaning, all temperatures are stable.

(a) Draw an energy flow diagram for this system with three **boxes** representing (i) the surface of the Earth, (ii) the first plexiglass layer, (iii) the second plexiglass layer. Draw **arrows** to represent energy transported by short-wavelength light (solar radiation centered around 500 nm) and long-wavelength light (earth glow centered around 10,000 nm). If energy is being exchanged in two directions, show this with two separate arrows.

(b) The surface of the earth has temperature T_{surf}, the first plexiglass layer has temperature T_1, and the second plexiglass layer has temperature T_2. Treat these as unknowns (we will determine them in part c). Use the idea of balanced energy rates to write down a set of mathematical relationships relating T_{surf}, T_1 and T_2. Other parameters that may appear in your expressions include:
I_{sun}, intensity of sunlight
R_{earth}, radius of Earth
σ, the Stefan-Boltzmann constant

Note: Remember that the absorption of Sunlight depends on the size of the earth's shadow, not on the surface area of the earth.
Note: The surface area of the plexiglass layers are almost equal to the surface area of the Earth (the difference is negligible).

(c) Let $I_{\text{sun}} = 1360$ J/(s m^2) and solve for T_2, T_1 and T_{surf}. Give your final answer in both kelvin and your preferred unit for describing air temperature.