Homework 1: Due Sep. 9, 2014

Hand in a hard copy at the beginning of class. Show your work.

1. Do question 1 on page 88 of the text.

2. Consider a photovoltaic (PV) panel that generates 1 KW with 500 nm wavelength light.

   (a) Incident solar radiation at the top of the Earth's atmosphere is $S_0 = 1370\,\mathrm{W/m^2}$, and average albedo is $\alpha = 0.31$. Show that the average incident solar radiation at the Earth's surface is $S = (1-\alpha)\frac{S_0}{4} = 236\,\mathrm{W/m^2}$.

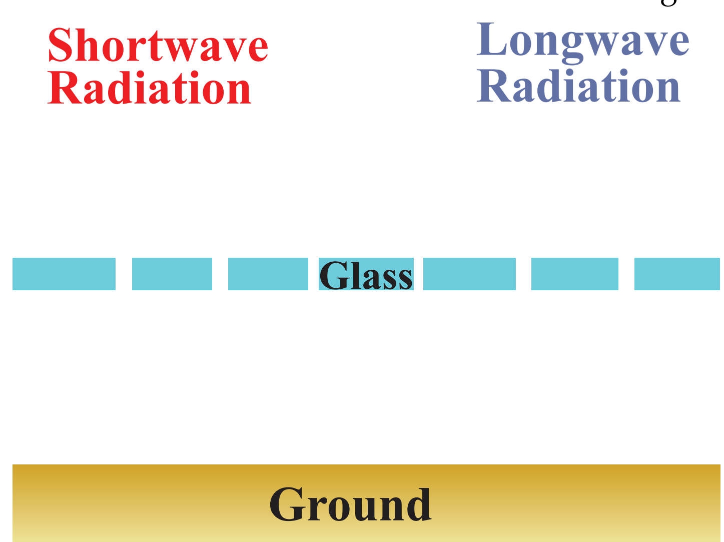
   (b) For the average incident energy at the Earth's surface, E, how big does this panel need to be?

   (c) How many photons is the panel collecting per second?

   (d) In very general terms, how do you think a PV cell works? (only 1 or 2 sentences).

3. Consider a planet with a simple perforated glass atmosphere. A fraction e of the simple atmosphere is glass, and $(1-e)$ of the simple atmosphere is *hole*. The glass and the planet are perfect black-bodies, absorbing then radiating all their energy. The glass is completely transparent to shortwave radiation, however, the planet has an albedo of α.

   (a) Draw and label EM radiation flux arrows on the figure (or copy). In addition to e, and α defined above, use $S\ (= S_0/4)$ for solar radiation, R_p for radiation from the planet, and R_a for radiation from atmosphere. Make sure you locate the arrows under the correct shortwave or longwave heading.



(b) Write steady state radiation balances for above and below the atmosphere. Then write expressions for R_p and R_a.

(c) Write equations for T_p planet surface temperature, and T_a atmospheric temperature.

(d) Calculate S_0 for Mars. You will need to look up distances.

(e) Calculate T_p for e = 0, 0.5, and 1 using S_{Mars}, and $\alpha = 0.17$.