PHYS320, Fall 2015

HOMEWORK SET 10

Due October 22, Thursday

1. To estimate a planet's equilibrium temperature, assume that the planet is a spherical blackbody of radius R_p and temperature T_p in a circular orbit a distance D away from the Sun. For simplicity, we will assume that the planet's temperature is uniform over its surface and that the planet reflects a fraction a of the incoming sunlight (a is known as the planet's **albedo**). From the condition of thermal equilibrium, the sunlight that is not reflected must be absorbed by the planet and subsequently re-emitted as blackbody radiation. Of course, we will also treat the Sun as a spherical blackbody having an effective temperature T_S and radius R_S. Use the Stefan-Boltzmann law and simple geometry to derive the temperature T_p of a planet at a distance D from the Sun:

$$T_p = T_S(1-a)^{1/4}\sqrt{\frac{R_S}{2D}}$$

2. Mercury's albedo is 0.12. The average distance from Mercury to the Sun is 0.387 AU = 5.79×10^7 km. Using the equation derived in Problem 1, estimate the surface temperature on Mercury.

3. Venus's albedo is 0.59. The average distance from Venus to the Sun is 0.723 AU = 1.082×10^8 km.
(a) Using the equation derived in Problem 1, estimate the surface temperature on Venus.
(b) Explain why the calculated the surface temperature is lower than the real one on Venus.