

## 12.400: The Solar System

### Problem Set #2

Useful Constant:

Stefan-Boltzmann constant,  $\sigma = 5.67 \times 10^{-8} \text{ J sec}^{-1} \text{ m}^{-2} \text{ K}^{-4}$

Please show all work *neatly and clearly*. Circle final answers for clarity.

### THE FATE OF THE EARTH

1. When will the Sun exhaust its supply of hydrogen and no longer maintain the same state of hydrostatic equilibrium that exists today? (Assume that the Sun will run out of hydrogen fuel in its core, due to inefficient mixing, after 5% of the Sun's current total hydrogen content is converted into helium.)
  
2. After the Sun ceases to be in its current state of hydrostatic equilibrium, it will become a red giant star.
  - a. What will be the radius of the Sun when it becomes a red giant star, assuming it has a luminosity of  $3.83 \times 10^{30} \text{ J sec}^{-1}$  and a surface temperature 5000 K?
  - b. Will the red giant Sun engulf the Earth?
  - c. What is the change (in percent) in the power ( $\text{J sec}^{-1}$ ) being emitted by the Sun once it enters the red giant stage? (Compare with respect to the present Sun.)

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3. You are an astronaut standing on the surface of the Moon, looking back at Earth. Your friend in mission control on Earth, looks out the window at the Moon. If your friend on Earth communicates to you that she sees the phase of the Moon as:
  - A. New Moon
  - B. First Quarter Moon
  - C. Full Moon
  - D. Last Quarter MoonFor each of these, A through D, explain what phase the EARTH would appear to you, as viewed from the Moon.