Chapter 5

54)*Suppose the surface temperature of the Sun were about 12,000K rather than 6000K.* **a** *How much more thermal radiation would the Sun emit?* **b** *What would happen to the Sun's wavelength of peak emission?* **c** *Do you think it would still be possible to have life on Earth?*
a Using Stefan-Boltzmann's law the emitted power of radiation of a blackbody is equal to σT^4. Since we want to know how much more light (or thermal radiation) would emit from the Sun than if it were 12,000K, we need to take the ratio of thermal radiation of the Sun at 12,000K over the Sun at 6,000K ([emitted power at 12,000K]/[emitted power at 6,000K]). σ is both in the numerator and the denominator, so it cancels ($[\not\sigma(12{,}000K)^4]/[\not\sigma(6{,}000K)^4]$). Fortunately 12,000K is just 2 multiplied by 6,000K leaving only 2^4 in the numerator (i.e. $2^4[\cancel{6{,}000K^4}/\cancel{6{,}000K^4}]$). So the Sun would have 16 times the thermal radiation at 12,000K than it does at 6,000K. **b** Using Wien's law $\lambda_{max} = \frac{2{,}900{,}000 nm}{T(in Kelvin)}$. As previously stated the Sun at 12,000K is double of the Sun temperature at 6,000K, so the λ_{max} would be half the current value of the λ_{max} for the Sun. Plugging in the numbers the Sun has a λ_{max} of 483 nm, so the Sun at 12,000K would have a peak wavelength of emission at 242 nm. That is the Sun at 12,000K would be emitting primarily in the Ultraviolet portion of the spectrum.
c Life on Earth as we know it would not be possible. First, the Sun is the primary purveyor of heat to the Earth and the Sun is dumping out 16 times the amount of thermal radiation making Earth much warmer. The higher intensity of thermal radiation would also make Earth inhospitable because higher energy photons consistently bombing Earth's atmosphere would strip the Earth's atmosphere. Finally, the Sun would be giving off not only more radiation but more UV photons which are damaging to life.

Chapter 6

23)*How much greater is the light-collecting area of a 6-meter telescope than that of a 3-meter telescope?*
b) Four times. The light collecting area of a telescope is a circle so the ratio of their areas is the ratio of their radii squared ($[\not\pi R_6^2]/[\not\pi R_3^2]$). Since the radius of a 6-meter telescope is twice that of a 3-meter telescope, the light collecting area is 2^2 or a factor of four larger.

26)*The Hubble Space Telescope obtains higher-resolution images than most ground-based telescopes because it is*
c) above Earth's atmosphere. The turbulent motion of the Earth's atmosphere smears the light from a star causing the resolution of the observation to lower than the instrumental resolution of the telescope. In space there is no atmosphere, so the Hubble Space Telescope is able to obtain resolutions limited only by its instrumentation.

Chapter 7

28) *Planetary orbits are*
c) fairly circular and in the same plane. This is one why reason Pluto was downgraded from planetary status. It also indicates that planets likely formed in a disk of material surrounding the young Sun.

30) *The most abundance ingredient of the Sun and Jupiter is*
b) hydrogen. The Sun is 98% Hydrogen by mass, while Jupiter is also largely composed of Hydrogen and Hydrogen compounds.

39) *How many Earths could fit inside Jupiter (assuming you could fill up all the volume)? How many Jupiters could fit inside the Sun? The equation for the volume of a sphere is* $V = (4/3)\pi r^3$.
Assuming you could fill of the volume, one needs to take the ratio of the volumes for the different heavenly bodies. Planets and the Sun are all roughly spherical, so you can approximate their volumes by a sphere. All of the leading constants cancel so the ratio of volumes is just the ratio of radii cubed ($[V_1/V_2]=[R_1/R_2]^3$). A Jupiter radius is approximately 11 Earth radii so the volume of Jupiter is a factor of 1331 larger than Earth, so 1331 Earths could fit inside Jupiter. Repeating the same calculation for the Sun (109 Earth radii) and Jupiter 973 Jupiters would fit inside the Sun's volume. Or you could notice that 109 (the Sun's radius in Earth radii) is approximately a factor of 10 larger than 11 (Jupiter's radius in Earth radii). This means that 10^3 or approximately 1000 Jupiters would fit inside the Sun.

Chapter 8

45) *You are dating rocks by their proportions of parent isotope potassium-40 (half-life 1.25 billion years) and daughter isotope argon-40. Find the age for each of the following.* **a** *A rock contains equal amounts of potassium-40 and argon-40* **b** *A rock that contains three times as much argon-40 as potassium-40*
Mathematical insight 8.1 discusses how to do this problem. Effectively what you need to know is that potassium-40 decays to argon-40 and is the only way to produce argon-40. Therefore, the original amount of potassium-40 is just the current amount of potassium-40 plus argon-40. **a** The definition of a half-life is the time it takes an atom to decay to half its amount, so that fact that potassium-40 and argon-40 amounts are equal means one half-life has passed. Therefore, the rock is 1.25 billion years old. **b** Now the current amount of potassium-40 is one-quarter its original amount. This means the amount of potassium-40 has halved twice (i.e. $[1/2]\times[1/2] = [1/4]$), therefore two half-lives have passed. So we multiply the half-life of potassium-40 by 2, and the rock is 2.50 billion years old.