Homework 4

Astronomy 1

Due October 25, 2019

1. (7.13)
   Suppose a spacecraft landed on Jupiter's moon Europa (see Table 7-2), which moves around Jupiter in an orbit of radius 670,900 km. After collecting samples from the satellite's surface, the spacecraft prepares to return to Earth.
   (**a**) Calculate the escape speed from Europa.
   (**b**) Calculate the escape speed from Jupiter at the distance of Europa's orbit.
   (**c**) In order to begin its homeward journey the spacecraft must leave Europa with a speed greater than either of your answer to (a) or your answer to (b). Explain why.

2. (7.24)
   Consider a hypothetical trans-Neptunian object located 100 au from the Sun.
   (**a**) What would be the orbital period (in years) of this object?
   (**b**) There are 360 degrees in a circle, and 60 arcminutes in a degree. How long would it take this object to move 1 arcminute across the sky?
   (**c**) Trans-Neptunian objects are discovered by looking for "stars" that move on the celestial sphere. Use your answer from part (b) to explain why these discoveries require patience.
   (**d**) Discovering trans-Neptunain objects also requires large telescopes equipped with sensitive detectors. Explain why.

3. (8.46)
   (**a**) Figure 8-20c shows how astronomers determine the planet of HD 209458 has a surface temperature of 1130 K. Treating the planet as a blackbody, calculate the wavelength at which it emits most strongly.
   (**b**) The star HD 209458 itself has a surface temperature of 6030 K. Calculate its wavelength of maximum emission, assuming it to be a blackbody.
   (**c**) If a high resolution telescope were to be used in an attempt to record an image of the planet orbiting HD 209458, would it be better for the telescope to use the visible or infrared light? Explain your reasoning.

4. (8.47)
   (**a**) The star 2M1207 shown in Figure 8-16b is 170 lightyears from Earth. Find the angular distance between this star and its planet as seen from Earth. Express your answer in arcseconds.
   (**b**) The mass of 2M1207 is .025 that of the Sun; the mass of the planet is very much

smaller. Calculate the orbital period of the planet, assuming that the distance between the star and the planet shown in figure 8-16b is the semimajor axis of the orbit. Is it possible that an astronomer could observe a complete orbit in one lifetime?

5. (10.22)
   (**Box10 − 1**) In Box 10-1, we calculated the tidal force that Earth exerts on two 1 kg rocks located on the near and far sides of the Moon. We assumed that the Earth-Moon distance was equal to its average value. Repeat this calculation
   (**a**) for the Moon at perigree and
   (**b**) for the Moon at apogee.
   (**c**) What is the ratio of the tidal force on the rocks at perigree to the tidal force at apogee?

6. (10.23)
   (**Box10 − 1**) When the Moon originally coalesced, it may have been only one tenth as far from Earth as it is now.
   (**a**) When the Moon first coalesced, was Earth's tidal force strong enough to lift rocks off the lunar surface? Explain your answer.
   (**b**) Compared with the net tidal force that Earth exerts on the Moon today, how many times larger was the net tidal force on the newly coalesced Moon? (This strong tidal force kept the one axis of the Moon oriented toward Earth, and the Moon kept that orientation after it solidified.)