

Astronomy 16 – Modern Astrophysics

Fall 2014

Homework 2

due: Wednesday, September 17, 11 am

It is very important to present your solutions neatly and clearly. Use units when appropriate, state where your numbers come from, explain what you're doing unless it's very obvious. Use sketches when you think they'd be useful. Quite a few of the questions are multi-part; make sure you answer each part. Your solution for a question that asks for a specific quantitative answer should include an explanation, not just a number.

Hand in the homework in the box on the wall outside my office door by 11:00 am on Wednesday.

1. Ryden & Peterson problem 2.4 on the aberration of starlight (p. 60). Note that the phenomenon of aberration is discussed on pp. 57-58.
2. The Space Shuttle orbits (whoops! used to orbit...) at a relatively low altitude of 370 km above sea level.
 - a. Compute its orbital period using some version of Kepler's third law. (Note that you may need to know the radius of the Earth in order to solve this problem.)
 - b. Compute the force of gravity on an astronaut on the orbiting Shuttle. Express your answer as a ratio with respect to the force of gravity she feels when she's on the surface of the Earth.

- c. Given your answer to (b), why does she experience “weightlessness” while in orbit?
 - d. Ryden & Peterson problem 3.6 (p. 81). Express a_{gs} in Earth radii as well as meters.
3. Consider two objects orbiting the Sun. Their orbits have the same size semi-major axis, a . But one is on a circular orbit and the other one is on a highly eccentric orbit ($e = 0.9$). The object on the eccentric orbit has a distance from the Sun, r , that is constantly changing. During one full orbital period, is $r > a$ for a majority of the time? A minority of the time? Or half the time?
4. Ryden & Peterson problem 5.3 (p. 144).
5. Look at Fig. 5.2 on p. 117 to answer this question. You might also refresh your memory about the recombination process discussed near the end of sec. 5.2. Consider a free electron that recombines with a proton to form a neutral hydrogen atom. Let’s say that the electron first recombines to the $n = 4$ level, emitting a photon, then a moment later makes a transition from the $n = 4$ level directly to the $n = 2$ level, emitting another photon, and then finally makes a transition from the $n = 2$ level to the ground state, emitting a third photon. Based on the information about this “recombination cascade” answer the following questions:
 - a. If the first and second photons emitted have the same energy, then what was the kinetic energy of the electron (in eV) before it recombined?

- b. Which, if any, of the three photons are in the visible part of the electromagnetic spectrum? (Make sure you state how you know this.)
- c. Can the third photon that's emitted photoionize another neutral hydrogen atom if that atom's bound electron is in the ground state? What if it's in the $n = 2$ state?