

ASTRONOMY 143
The History of the Universe
Professor Barbara Ryden

Problem Set # 3
Due Wednesday, October 21
at class time

NAME (print clearly): _____

SCORE (instructor use): _____

1) [20 points] You are given a ticket for running a red traffic light. For an observer halted at the red light, the light emits a wavelength $\lambda_0 = 700 \text{ nm}$. You tell the traffic cop that because you were approaching the light, the Doppler shift made it appear green ($\lambda = 500 \text{ nm}$). How fast would you have been going if this smart-aleck explanation had been true? Please express this speed in units of miles per hour. [Hint: There are 1.6093 kilometers in a mile.]

2) [20 points] Astronomers doing a “star census” of the solar neighborhood have found that there are 340 stars within a distance $r = 10$ parsecs of the Earth. Compute the volume of a sphere of radius $r = 10$ parsecs centered on the Earth. Compute the average number of stars per cubic parsec within this sphere.

3) [20 points] As shown in the textbook (Figure 3.25), the Milky Way Galaxy can be approximated as a cylinder whose diameter is $d = 100,000$ light-years and whose thickness is $h = 2000$ light-years. What are the diameter and thickness in units of parsecs? What is the volume of the Milky Way Galaxy in units of cubic parsecs? Assume that the average number of stars per cubic parsec in the Milky Way Galaxy is the same as the number of stars per cubic parsec in the solar neighborhood: what, in this case, is the total number of stars in the Milky Way Galaxy?

4) [40 points] Suppose you have a friend, “Flat-Earth Fred,” who believes that the Earth is flat rather than spherical. (He believes that all the NASA photographs showing a spherical Earth are faked; he wants evidence that he can see directly with his own eyes.)

First, describe what evidence you could provide, without having to leave Columbus, that the Earth is spherical. [Hint: On June 29, 2010, there will be a lunar eclipse visible from Columbus.]

Second, suppose that you have a private jet and can fly anywhere in the world where there’s an airport. With this added mobility, what additional evidence could you provide to convince Fred that the Earth is spherical?