Astron 211 Problem Set 9

Given: Nov 15. Due: Nov 22 at the beginning of class

Homework Policy: You can consult class notes and books. Always try to solve the problems yourself; if you cannot make progress after some effort, you can discuss with your classmates or ask the instructor. However, you cannot copy other's work: what you turn in must be your own. Make sure you are clear about the process you use to solve the problems: partial credit will be awarded.
Reading: Kutner Chapter 22–25, 4

Problem 1 Kutner Problem 22.11

How does the kinetic energy of an object with the escape speed at a distance r from a mass M compare with that of an object in a circular orbit of radius r?

Problem 2 Kutner Problem 23.6

Express the equilibrium temperature of a planet as a function of that of the Earth and the distance of the planet from the Sun in astronomical units. In other words, we want an equation:

$$T = f(T_\oplus, a)$$

where a is expressed in AU. Use your equation to construct a table of the equilibrium temperatures for the 8 planets.

Problem 3 Kutner Problem 24.5

The law of hydrostatic equilibrium is:

$$\frac{\Delta P}{\Delta r} = -g\rho$$

where ΔP is the change in pressure and Δr the change in radius between two points.

Use this to compute how far under water do we have to go on Earth to obtain a pressure of 90 atmospheres?

Problem 4 Kutner Problem 25.5

What is the ratio of solar energy per second per unit surface area (i.e., W/m^2) reaching Uranus to that reaching Neptune?

Problem 5 Kutner Problem 4.2

Estimate the angular resolution of a 5 m diameter optical telescope in space.

Problem 6 Kutner Problem 4.16

What is the angular resolution of *HST* at 200 nm wavelength?

Problem 7 Kutner Problem 4.22

Two infrared sources in the Orion Nebula are 500 pc from us and are separated by 0.1 pc. How large a telescope would you need to distinguish the sources at a wavelength of 100 μm?

Problem 8 Kutner Problem 4.26

Two infrared sources in the Orion Nebula are 500 pc from us and are separated by 0.1 pc. How large a telescope would you need to distinguish the sources at a wavelength of (a) 21 cm? (b) 1 mm?

Problem 9 Order of Magnitude: Tea

Radio astronomy started in earnest in the 1960's with the construction of the 300-m Arecibo Telescope. Strong sources have flux densities of about 1 Jansky, or $10^{-26}\,W/m^2/Hz$. Assume that a radio telescope can add up the signal over a bandwidth of 100 MHz, how much energy total has been received by the Arecibo Observatory since it started? Would this boil a cup of tea?