University of California, Santa Barbara

Astronomy 2
Spring 2012

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Assignment # 1
Due: Tuesday, April 10, 2012

Instructions

On this and future assignments, please write your name on all pages and staple all pages together. Write very clearly!

Please be sure to explain your answers to all word problems briefly but carefully, and to show all your work on the calculations. The grade on each problem will reflect more on the verbal explanations and calculations shown rather than the final answers, especially considering the fact that we'll usually provide the answers.

You may work with others on the homework problems, but you must write them up yourself, using your own words and calculations. If you hand in a paper identical to someone else's, neither of you will get any credit because we won't know whether or not you actually did the work.

Also, the solutions will be shown on our class website very soon after the due date: http://web.physics.ucsb.edu/∼astro2/s2012/. Partly for this reason, we cannot accept late homework! (**Only exception: if you have an emergency and tell me before the due date**).

SHOW ALL WORK

These questions use the Inverse Square Law, the Blackbody laws (Stefan-Boltzmann and Wien), the small-angle formula and the formulas for area of a circle and surface area of a sphere.

1. In the mks metric system the unit of energy is the Joule. Approximately 1400 Joules of sunlight fall on each square meter of the Earth directly below the sun each second.

a. Use the distance from the Sun to the Earth, 1.50×10^{11} m, to calculate the total luminosity of the sun. Answer about $3.96 \times 10^{26} \frac{J}{s}$, or Watts.

b. The Sun's surface temperature is 5800 K. At what wavelength does it radiate most? (Remember that all quantities used in Formulae must be expressed in *Consistent Units*). Answer: about 5.0×10^{-7} m, or 5.0×10^{2} nm, or 0.5 micron.

c. The sun subtends an angle of 0.5 degree as seen from earth. Calculate its radius using the small angle formula. Answer: about 6.5×10^{8}m, or 650,000 km.

d. Recall that opaque bodies radiate a power or luminosity of a σT^4 per square meter, where σ is Stefans Constant (5.67×10^{-8} in mks units). Based on the information given, calculate the Sun's luminosity. Compare with your answer to part a). Answer: about $3.41 \times 10^{26} \frac{J}{s}$. This agrees fairly well with the answer to part a); the difference is mostly because the Sun is actually a little more than half a degree across.

2. Our neighboring galaxy Andromeda is 600 kpc distant. Stars 1" from the center are orbiting at $110 \frac{km}{s}$, indicating the presence of an unseen massive dark object, a Supermassive Black Hole! What is the mass of this black hole? You need to know that an object in a circular orbit is always accelerating at a rate given by $\frac{\nu^2}{R}$, where ν is the velocity and R is the orbital radius. (answer: somewhat above $10^7 M_\odot$, where $M_\odot$ is the sun's mass.)

3.

a. What are the stages in the life of a solar-type star?

b. What type of object will the Sun ultimately become? What will the chemical composition be?

c. Explain briefly, but carefully, the "main-sequence turnoff" method for finding the ages of star clusters.

d. What are the stages in the evolution of a massive star, for example a star with $10 M_\odot$.

4. Write down three very clear specific questions about our current class work or other topics in astronomy. Write questions for which you really want to know the answers, not things like "What's Einstein's birthday?" I'll answer some in class. If I have not answered yours, you can ask me or your TA! This is part of the homework, so take it seriously.