HOMEWORK #7 (due start of class Feb 3)

LEARNING GOALS for this assignment:

1. To understand deeper concepts of electromagnetic energy: Flux, magnitudes, luminosity, inverse square law of brightness, …
2. To apply this understanding in practical situations in modern astronomy.

TO RECEIVE FULL CREDIT:

1. Staple multiple pages and identify yourself by Star Name (worth 5 points!).
2. You must **show how** you derived your answer by writing all the logical steps that led you to it. Follow the format of the "Homework Example" on our Web site.
3. All sentence responses must be typewritten and in complete sentences. You may handwrite any arithmetic. Use good English grammar.
4. **If you work more than three hours on this assignment, you should stop, record your work here, and contact Dr. McCarthy or Mr. Hammer (our Teaching Assistant) for help.**

Electromagnetic Radiation: Flux, Intensity, Luminosity, Magnitudes, …

Part I. In Ryden and Peterson's textbook, read section 13.3.

Part II. Answer question #1 plus two of the remaining four questions.

1. Imagine a binary star system with two stars. The individual stars have apparent magnitudes of $m_v = 3$ and 4, but from Earth we see their light combined; i.e., the two stars are "unresolved" with an integrated (i.e., combined) magnitude. What is the apparent magnitude of the unresolved pair of stars? [NOTE: Since magnitudes are logarithmically related to flux, you cannot simply add two magnitudes together to find the total apparent magnitude of an unresolved binary star.]

2. A certain globular star cluster has a total of 10^4 stars. One hundred of those stars have $M_v=0.0$ and the rest have $M_v=+5.0$. What is the integrated (i.e., combined) visual magnitude of the cluster?

3. Astronomers often use the approximation that a 1% change in brightness of a star corresponds to a change of 0.01 magnitudes. Justify this approximation.

4. The apparent magnitude of an object can change because of intrinsic and/or extrinsic effects. It is important to be able to convert between magnitudes and brightness (flux), so below are some examples.

a. As the asteroid 4 Vesta rotates, its apparent magnitude at visual wavelengths changes by 0.12 mag. What is the corresponding variation in flux?

b. Over the Sun's 11-year sunspot cycle, the Sun's luminosity varies by 0.1%. What is the corresponding change as expressed in magnitudes?

5. The binary star Algol ($m_v=2.1$) consists of two "unresolved" stars orbiting each other every 2.867328 days. This week you can see the stars eclipse and reach a minimum magnitude ($m_v=3.4$). The dimming process lasts ~5 hours, as does the subsequent brightening. Algol will reach its minimum magnitude at these times: Feb 3 (1:31 am); Feb 5 (10:21 pm); Feb 8 (7:10 pm)

As illustrated below, the Earth lies in the orbital plane of these stars, so we regularly see the two stars eclipse as they take turns moving in front of each other. The diagrams below illustrate this

process as well as the variation in brightness (flux) vs time over one full cycle. Convert that variation in flux to a variation in magnitude.