

Homework 5: Due **Wednesday October 18th, 2006**, in class (or turn them in before then to my mailbox, 5th floor, Sterling Hall). Show your work (for partial credit if you make an arithmetic error).

1. The main mirror of the Hubble Space Telescope is only 2.4 meters in diameter, while the Southern African Large Telescope (SALT – UW has a 1/6 share of this!) has a mirror 11 meters across. How many times more light-gathering power does SALT have than Hubble?

The Hubble telescope can see much finer detail than SALT, even though it is smaller: why?

2. The Sun gives out a luminosity $L = 4 \times 10^{26}$ W. Use the formula $E=mc^2$ to calculate how much of the Sun's mass is turned into energy each second to produce this light: if E is in watts, you must write c in meters/sec, then m is in kilograms per second.

If the Sun could turn all its mass (2×10^{30} kg) into energy, for how many billion years would it shine?

In fact the Sun can turn only about 0.1% of its mass into energy: for how long will it live?

3. Two stars, A and B, are equally luminous – they give out the same amount of light energy. Star A is four times more distant. How many times more or less bright does star A appear (how many times larger or smaller is its flux), compared to star B?

Star C is four times more luminous than star D, but they appear equally bright. How much more distant must star C be than star D?

Star F is nine times more luminous than star G, but it is four times further away. How many times brighter or dimmer does star F appear, compared to star G?

4. When the Sun becomes a red giant, it will expand so its diameter is about 1 AU (look forward to Figures 13.15 and 15.10). How many times larger is this than the Sun's present size? How many times larger will the Sun's surface area become?

As a red giant, the Sun will be about 2,000 times more luminous than it is today. How many times more or less energy will the Sun give out from each square meter, compared with today?

Use the Stefan-Boltzmann formula (Box 12.2) to find out how many times cooler this red giant will be, compared to the Sun today. (Look at Figure 13.15 to see if your answer makes sense.)

The Sun's surface temperature is 6,000 K. At what wavelength does it give out most of its light?

When the Sun becomes a red giant, what will its surface temperature be? At what wavelength will it emit most of its light?

In the Sun's spectrum, we see a dark line absorption line $H\alpha$ of hydrogen at 656 nm. At what wavelength will we see this line when the Sun becomes a red giant?