

Astronomy 110: Survey of Astronomy

Homework #3

(Due June 17th, 2005)

1. Einstein once said:

$$E = mc^2$$

If 0.7% of the mass of four protons is converted into energy when they form a helium atom, how much energy (E) does the Sun produce (in Joules) for each helium atom it creates? Here are some facts you'll need:

$$1 \text{ Joule} = 1 \text{ kg m}^2 / \text{s}^2$$

$$m_{\text{proton}} = 1.67 \times 10^{-27} \text{ kg}$$

$$c = 3 \times 10^8 \text{ m/s}$$

(Remember, 100% = 1.0)

2. [Ch. 10, problem 31 – slightly modified] *The Sun and Global Warming*. One of the most pressing environmental issues on Earth concerns the extent to which human emissions of greenhouse gases are warming our planet. Some people claim that part or all of the observed warming over the past century may be due to changes on the Sun, rather than to anything humans have done. For this reason, President Bush has stated that we need more information before we can take action on global warming. Discuss how a better understanding of the Sun might help us to understand the threat posed by greenhouse gas emissions. Why is it so difficult to develop a clear understanding of how the Sun affects Earth's climate? How long might it be before we have enough definitive evidence either way in order to take action (if necessary)?
3. The Stefan-Boltzmann Law states that a star's luminosity, temperature and size are related as:

$$L = 4\pi R^2 \sigma T^4$$

- a. If a star has a surface temperature twice as high as that of the Sun, but the same surface area, by what factor is the star more luminous than the Sun? (*Please show your work*)
- b. If a red giant has half the Sun's surface temperature but 100 times its radius, by what factor is the star more luminous than the Sun? (*Please show your work.*)

4. [Ch. 11, problem 26] *Stellar Data*. Consider the following data table for several bright stars. M_v is the absolute magnitude, and m_v is the apparent magnitude. (Hint: Remember that the magnitude scale runs backward, so that brighter stars have smaller (or more negative) magnitudes.)

Star	M_v	m_v	Spectral Type	Luminosity Class
Aldebaran	-0.2	+0.9	K5	III
Alpha Centauri A	+4.4	0.0	G2	V
Antares	-4.5	+0.9	M1	I
Canopus	-3.1	0.7	F0	II
Fomalhaut	+2.0	+1.2	A3	V
Regulus	-0.6	+1.4	B7	V
Sirius	+1.4	-1.4	A1	V
Spica	-3.6	+0.9	B1	V

Answer each of the following questions, including a brief explanation with each answer.

- Which star appears brightest in our sky?
- Which star appears faintest in our sky?
- Which star has the greatest luminosity?
- Which star has the least luminosity?
- Which star has the highest surface temperature?
- Which star has the lowest surface temperature?
- Which star is most similar to the Sun?
- Which star is a red supergiant?
- Which star has the largest radius?
- Which stars have finished burning hydrogen in their cores?
- Among the main-sequence stars listed, which one is the most massive?
- Among the main-sequence stars listed, which one has the longest lifetime?