AST 301 Introduction to Astronomy

COMMENTS ON QUIZ 2

Part A

A1. 250 nm. Energy of photons/transitions scales directly as frequency and inversely as wavelength.

A2. Four stars = four answers
a. 25,000K b. 7000K c.3000K d.5000K

A3. b=continuum

A4. 5000K See $L=R^2T^4$

A5. A0V

A6. M5I

A7. d, e,a,c, b. By convention, radial velocities of approach are given as negative quantities and those of recession as positive quantities.

A8. $L=R^2T^4$ Thus, L/L_sun = 100 x (1/16) = 6.25.

A9. a.

A10. b.

A11. Pluto (assuming Pluto IS a planet!)

A12. 10:20:100 = 1:4: 100

A13. c. A14. e. (from $L=M^4$ and A13's answer)

A15. d.

A16. e.

A17 False.

A18. a.

A19. a.

A20. a.

Comments on Part B questions:

B1. (four answers).
a- This is addressed thoroughly in Class Notes 10
b- As for a
c- As for a

B2. (18 answers)
a- See Class Notes 13
b- As for a
c- See Comments on HW4

B3. (21 answers)
a- and
b- See your graphs for Part C of HW4
c- Recall that Luminosity is proportional to radius-squared times temperature to the fourth power. The arrow is drawn for constant luminosity but temperature increases from the arrow's base to its tip and, therefore, radius must decrease in order to keep the luminosity constant.

B4. (44 answers)
a- The luminosity (L) and mass (M) of a main sequence star are related such that L is proportional to M to the fourth power. Text suggests the relation is proportional to M to the 3.5 power. Four is a lot easier to handle!
This relation does not hold for other stars be they pre-main sequence protostars or post-main sequence giants and white dwarfs. For these diverse kinds of stars there is no simple relation between L and M.

b- For a complete answer, a justification was required. It was not sufficient to give the answers: one 10M_sun star for maximum brightness and 10 1M_sun stars for longest lifetime.
Justification calls for use of L proportional to M^4 and lifetime proportional to $1/M^3$. It's not necessary and is even unhelpful to say things like massive stars have denser cores, higher core temperatures and ......
Brightest: brightness scales as 10^4= 10,000 (case A) or 10 (1^4) = 10 (case B).
Longest duration: Lifetime of main sequence star scales as fuel/consumption = $M/L = M/M^4 = 1/M^3$. the 10M_sun star has a lifetime 1/1000 that of the 1M_sun star. Therefore go with case B for duration.

B5. (19 answers)
a- See Class Notes 13

b- You were asked to say why higher temperatures AND higher densities are needed to fuse He to C. The higher temperatures are needed to overcome the electrostatic repulsion between He nuclei. Higher densities are needed because the obvious initial step of He+He results in a VERY unstable product (Beryllium-8) which decays back to He+He unless it is hit at once by another He nucleus so that the requirement becomes a triple collision (3He --> C) and triple collisions demand high density.

c- Several answers gave `radiation and convection'. Convection is a mode of energy transport and is not a form of energy released in nuclear fusion reactions. See part 7 of Class Notes 13.

B6. (44 answers)
a- VERY few correct definitions of `a spectroscopic binary'. Why spectroscopic? Read Seeds and Backman on binary stars.

b- Given the inadequate definition of spectroscopic binary in part a, it was no surprise that almost all descriptions of the observations were also quite inadequate. The key here is again the word `spectrosocpic' - see Seeds & Backman - especially pp 192-194 and Figs. 9-18 and 9-19. Spectroscopic binaries may be composed of stars with very different luminosities and then the spectrum may show just one set of absorption lines whose radial velocity varies as the brighter star moves in its orbit. In the event that the binary has two stars not too different in luminosity, a spectrum will show two sets of absorption lines, as in Fig. 9-19.

c- Stars in a binary orbit under the influence of gravity. The further apart the stars are the weaker is the influence of gravity and the greater the distance the stars have to travel to complete their orbits and, thus, the longer the periods. For visual binaries, the separation of the stars is in general such that orbital periods are measured in years, often in decades. As the question indicated many (not all!) spectroscopic binaries have periods of days because the stars are closer together. (A very distant binary of long period is unlikely to be seen as a visual binary (OK?) but will be detectable as a spectroscopic binary. Thus, not all spectroscopic binaries have periods of a few days.)

B7. (three answers)
a- See Class Notes 15

b- This conclusion comes straightforwardly from simple estimates of the lifetime of main sequence stars (see Class Notes 13) which scales as

$1/\text{mass}^3$. The lifetime of the Sun is 10 billion years and the age of the Universe is just under 14 billion years. So, main sequence masses of slightly less than the mass of the Sun have age of 14 billion years or greater and thus have not yet exhausted their H supply.

c- Two possibilities. Stars, particularly beyond the main sequence, lose mass so that a single main sequence star of greater than 0.7 solar masses may appear as a red giant of less than 0.7 solar masses. A more likely scenario (see Seeds & Backman on the Algol Paradox) is that the red giant belongs to a binary system in which it was the more massive star. This star became a red giant but its outer envelope was transferred to its (initially) less massive companion with the transfer reducing the mass of the red giant below the 0.7 solar mass limit. Many types of puzzling and, therefore, interesting stars result from binary stars in which stars do NOT evolve as isolated single stars.