AY2 Homework for Quiz 2: Fall 2019

Erg=CGS unit of energy=gram·cm^2/$second^2$; $E=mc^2$ in units of ergs if "m" is in grams and "c"=$3x10^{10}$ cm/sec;

1. **Star A has twice the trigonometric parallax and twice the luminosity of Star B (assume no dust toward either star).**

   a) What is the relative distance of the two stars?

   Star A is ½ the distance of Star B

   b) What is the relative brightness of the two stars?

   If the same luminosity, Star A would be 4x brighter than B based on the distance ratio. At twice the luminosity of B, Star A will be 4 x 2= 8 times brighter than B

2. **The Sun will eventually go through which of the following phases?**

_**x**__ planetary nebula

_x__ red-giant branch

___ SNII

_x__ white dwarf

3. **In the fusion of four protons into helium, 4.7×10^{-26} grams of material is converted into energy. How much energy does this amount of matter produce?**

   $E=mc^2=(4.7x10^{-26}$ gr) x $(3 \times 10^{10})^2$ = (4.7 x 9) x 10^{-6} ergs

4. **Which of the following are True (T), which False (F)?**

__**T**_ The fraction of the Sun composed of helium is larger than it was 1 billion years ago.

_T__ The Sun is losing mass every day

_F__ The fraction of the Sun composed of Fe is larger than it was 1 billion years ago

_F__ The luminosity of the Sun decreases a small amount every day as it uses up its hydrogen fuel

5. **Given that hydrogen fusion to helium produces 10^{18} ergs of energy per gram of hydrogen:**

    A. How much energy can the Sun produce via this mechanism with the 2×10^{32} grams of hydrogen in the core where the temperature is hot enough for fusion to occur?

E=10^{18} ergs/gr x 2 x 10^{32} gr = 2 x 10^{50} ergs

    B. How long could the Sun produce energy via this hydrogen fusion at its luminosity of 4×10^{33} ergs/second?

    Time= (2 x 10^{50} ergs)/(4 x 10^{33} ergs/second)=0.5 x 10^{17} seconds

6. **In a SN I outburst, the initial burst of light is due to the energy released in fusion reactions. What keeps the SN glowing after the first 15 days? (select one)**

___ A. Neutrino heating
___ B. Photo-disintegration of Iron nuclei
___ C. Radioactive decay or Nickel and Cobalt formed during the explosion
___ D. Radioactive decay of Hydrogen and Helium

7. **Which of the following are used in measuring stellar masses (check any that are true)?**

___ A. Proper motion measurements of nearby stars
___ B. Radial velocity measurements of stars in binary systems
___ C. Red Giants that are within 100pc of the Sun
___ D. Newton's Laws of gravity

8. **The Solar luminosity at the Earth is 3.9×10^{33} ergs/sec. What is it at the distance of Jupiter (5 AU or 5 times the distance from the Sun compared to Earth)?**

____ A. 3.9 x 10^{33} ergs/sec
____ B. (3.9 x 10^{33})/5 ergs/sec
____ C. (3.9 x 10^{33})/5^2 ergs/sec
____ D. (3.9 x 10^{33}) x 5^2 ergs/sec

9. **"Hydrostatic" models for the Sun or other stars are based on (check any that are correct):**
   ____ A. Gas pressure compressing stars to the point just before they become liquid
   ____ B. Balancing the force of gravity and gas (thermal) pressure at every radius
   ____ C. The laws of physics governing the fusion of the elements
   ____ D. Static electricity providing support against gravitational collapse

10. **The principle behind determining stellar radius or surface area is best described by (select one):**

   ____ A. Using stellar luminosity combined with Wien's Law for the peak radiation as a function of temperature
   ____ B. Using the distance determined from parallax and the apparent size of a star
   ____ C. Using stellar luminosity, stellar surface temperature and Stephan's Law that related temperature and radiated energy for a surface
   ____ D. Using binary stars and radial velocity measurements

11. **Which of the following statements are True (T), which (F) regarding the Main Sequence in the Hertzsprung-Russell Diagram:**
   ____ A. It is a mass sequence with the lower-mass stars at the low-temperature/low-luminosity corner and the higher-mass stars at the high-T/high-L corner TRUE
   ____ B. It is the sequence of stars that are in equilibrium fusing hydrogen to helium in their cores TRUE
   ____ C. Stars start their lives in the cool-T/low-L corner and evolve along the Main Sequence as they age and get hotter FALSE
   ____ D. Once a star is on the Main Sequence, it stays there for at least 10 billion years FALSE

12. **High temperature is required for hydrogen fusion because (check one):**
   ____ A. Only at high temperatures do the protons approach close enough for the nuclear force to overcome the electrical force
   ____ B. Only at high temperatures can gravity be balanced
   ____ C. Hydrogen can not be fused unless oxygen is present and that only occurs at "burning" temperatures

13. **Why does hydrogen fusion only occur at the center of the Sun?**

The required temperature of at least 10 million K only occurs in the central region

14. **How much energy is released by the reactions in the core of the Sun each second?** 3.9×10^{33} erg

15. **For two stars on the Main Sequence of the H-R Diagram, compare the luminosity of Star F and Star G if Star G has a higher surface temperature and is at twice the distance of Star F.**

Distance is not relevant. On the main-sequence, the hotter star is more luminous

16. **Four stars occupy the four corners of the H-R diagram (UL, LL, UR, LR):**

_______ A. In which corner(s) is (are) the largest star(s)? UR
_______ B. In which corner(s) is (are) the most luminous star(s) (UL, UR)
_______ C. In which corner(s) is (are) the hottest star(s) UL, LL
_______ D. In which corner(s) is (are) the lowest-mass star(s) LR

17. **Which of the following are true (T), which false (F) about the white dwarf the Sun will eventually become?**

___ A. It will have become slightly more massive than the Sun is now because lightweight hydrogen has been converted into heavier Helium FALSE
___ B. It will be enriched in helium compared to the Sun TRUE
___ C. It will initially have a much higher surface temperature than the Sun TRUE
___ D. It will be supported against gravity by electron degeneracy forces TRUE

18. **Which of the following support the theory of SN II: core-collapse supernovae?**

___ A. SN II are always seen near regions of star formation
___ B. The supernova remnants in the Galaxy show evidence of heavy element enhancements
___ C. There are pulsars (rotating neutron stars) at the centers of some SN II remnants
___ D. They have luminosities similar to red giant stars

19. **Which of the following are predicted properties of the neutron star left behind by a SNII?**

____ A. They will initially have very high surface temperatures
____ B. They will be spinning very rapidly
____ C. They will have much higher densities that main sequence stars or white dwarfs
____ D. They will be supported by gravity by neutron degeneracy

20. Which of the following are part of the story that explains a SN I explosion?

____ A. Core collapse of the iron core of a massive star
____ B. Mass transfer in a close binary onto a white dwarf
____ C. Violent stellar collisions in star clusters that force objects over the Chandrasekar Limit
____ D. Explosive nucleosynthesis that produces radioactive nickel and cobalt

21. Why do we expect a freshly-formed neutron star to be rapidly rotating.

Conservation of angular momentum and the large ratio of the radius of the iron core that collapsed to the radius of the neutron star

22. The lowest-luminosity white dwarfs in the Galaxy have about 10^{-5} the luminosity of the Sun. Why are there no whites dwarfs at lower luminosities than this?

The Galaxy has a finite age

23. How long will a star with 10 times the mass of the Sun and 10,000 times the luminosity of the Sun spend on the Main Sequence of the H-R Diagram?

Relative age is proportional to the mass and inversely proportional to the luminosity so it will last 10/10000 = 1/1000 the main-sequence lifetime of the Sun. This is

$10^{-3} \times 10^{10} = 10^{7}$ year

24. Why don't White Dwarfs collapse to smaller radius due to gravity? (check any that are correct).

____ A. They are supported by hydrogen fusion
____ B. All white dwarfs are in the process of slowly collapsing till they become neutron stars
____ C. They are supported by electron degeneracy
____ D. They are already a super density fluid and fluids can not be compressed