What You Should Know About “Stars With Less Than 8 Solar Masses”!

1.) That is, what basic characteristic makes a star a star? (fusion is happening in its core)

2.) How long will it take a small star to run out of hydrogen to fuse? (about 10 billion years)

3.) What temperature is required to fuse hydrogen? (10,000,000 degree Kelvin)

4.) How long will it take a small star to run out of helium to fuse? (around 10 million years)

5.) What temperature is required to fuse helium? (100,000,000 degrees Kelvin)

6.) When a small star's core begins to run out of hydrogen to fuse, what happens to:

a.) It's core? (gravity takes over, the core begins to shrink and as it does, it begins to heat up; also, the core is primarily He now)

b.) The region just outside the core? (due to the core's heating, the shell outside the core ignites into hydrogen fusion)

c.) It's luminosity? (due to hydrogen fusion in shell just outside core, the luminosity increases)

d.) It's radius? (due to energy output from fusion in the shell outside the core, the outer region of the star begins to expand so the radius increases)

e.) It's surface temperature? (because the radius increases, the larger energy output (luminosity) is spread out over a larger surface area, so the surface temperature goes *down*—that is less energy is passing out *per unit area*)

f.) It's position on the H-R diagram? (It moves upward due to larger luminosity and to the right due to lower surface temperature, become a *red giant*)

7.) When does the star finally starts to fuse helium? (when the core temperature reaches 100,000,000 degrees Kelvin)

8.) What elements are conspicuously absent during the helium fusion phase of the star's life? (Li, Be and B)

9.) Where do the elements alluded to in # come from if not from fusion at the star's core during the star's life? (this will be answered when we talk about the death of stars greater than 8 solar masses)

10.) When a star slows its helium fusion, where does it go on the H-R diagram? (migrates to the red supergiant stage)

11.) How big is a *red supergiant* in comparison to the sun? (400 to 600 times the diameter)

12.) What temperature is required to begin carbon fusion? Do stars smaller than eight solar masses ever get to this point? (600,000,000 degrees Kelvin, and smaller stars can't reach this temperature)

13.) When a small star's core begins to run out of helium to fuse, what happens to:

a.) It's core? (gravity takes over, the core begins to shrink and as it does, it begins to heat up; also, the core is primarily carbon now)

b.) The region just outside the core? (due to the core's heating, the shell outside the core ignites into helium fusion; just outside that, hydrogen fusion)

c.) It's luminosity? (due to the fusion in shells outside core, the luminosity increases)

d.) It's radius? (due to energy output from fusion in the shells outside the core, the outer region of the star begins to expand so the radius increases)

e.) It's surface temperature? (because the radius increases, the larger energy output (luminosity) is spread out over a larger surface area, so the surface temperature goes *down*—that is less energy is passing out *per unit area*)

f.) It's position on the H-R diagram? (It moves upward due to larger luminosity and to the right due to lower surface temperature, become a *red super giant* with a diameter 400 to 600 times the size of the sun)

14.) With no carbon fusion happening in the core, the core continues to contract, heating as it does. As this happens, what happens to:

a.) The shells and material outside the core? (they continue to fuse hydrogen and helium, but they do it faster and faster as the temperature of the core increases)

b.) The core itself? (it gets hotter and hotter, but never reaches the 600,000,000 degrees Kelvin needed to begin Carbon fusion—the contraction continues until you have a core whose density is equivalent to compressing a car into the size of a marble)

c.) What happens to the outer shell of material (outside the fusing shells)? (it continues to expand outwards, cooling in the process—at some point, the outer shell is expelled as a *planetary nebulae* leaving the hot, white core exposed)

d.) What is the name given to what is left? (a white dwarf)

f.) Where on the H-R diagram are white dwarfs found? (high temperature, so leftward; low energy output, so lower)

g.) What rather prominent star in your life is going to die this way? (sun)

15.) So on an H-R diagram, aside from the obvious, what is the underlying difference between a *main sequence star*, a *red supergiant* and a *white dwarf*? (they are all the same kind of star, just at different stages in their life cycle)