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|  **Web Quest: Discovery Sheet 1: The Chemistry of Stars** |
| http://can-do.com/uci/ssi2000/nineplanets32.gif   Directions: Use the Internet web sites below along with any text resources that you have to answer the questions. Some of the questions require only that you locate specific information, other questions (a bit more challenging) involve more critical thinking, requiring you to make inferences and draw conclusions about the information you find.     http://can-do.com/uci/ssi2000/divider.gifhttp://can-do.com/uci/ssi2000/nineplanets32.gif  Web Resources: Use these links as your primary resources for finding the answers to the questions below.   * [Web Elements](http://www.webelements.com/index.html)--excellent resource for finding information on elements
* [Chemistry OnLine Textbook](http://library.thinkquest.org/3310/higraphics/textbook/u01s01.html#Introduction)--good source for review of basic chemistry
* [Elementary Astronomy--once](http://www.astronomynotes.com/) there, navigate to the "Lives and Deaths of Stars" link; this is a university site that could serve as your primary resource
* [Nuclear Fusion--text-based](http://www.physics.gmu.edu/classinfo/astr103/CourseNotes/ECText/ch17_txt.htm#17.2.1.) information on the fusion process in stars
* [Stars](http://www.astro.uiuc.edu/~kaler/sow/star_intro.html)--a comprehensive page about stars; this should also be one of your primary resources
* [Birth of stars--text-based](http://www.physics.gmu.edu/classinfo/astr103/CourseNotes/ECText/ch17_txt.htm#17.5.) information on stellar evolution
* [Evolution of stars--includes](http://zebu.uoregon.edu/textbook/se.html) a great animation of the HR diagram
* [Hubble Telescope Images--outstanding](http://oposite.stsci.edu/pubinfo/Subject.html#Evolution) images of stars in different stages of their life cycle
* [Yahoo astronomy sites--a](http://dir.yahoo.com/Science/Astronomy/) resource of links to many astronomy sites
* [Astronomy links--another](http://universe.colorado.edu/site/links.ssi) source of links to numerous astronomy sites
* Nuclear chemistry--a good primer on basic nuclear reactions
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| http://can-do.com/uci/ssi2000/divider.gifhttp://can-do.com/uci/ssi2000/nineplanets32.gif    Discovery questions: Answer the following using the web resources above. A. Basic nuclear chemistry: 1. What is the difference between *chemical* reactions and *nuclear* reactions (in which one are new elements produced and in which one are only new *combinations* of elements produced)?
2. Using a chemistry text or a web resource define the following: atomic number, mass number, isotope, nuclide, fission, fusion, alpha particle, beta particle, gamma ray, deuterium
3. Write the isotope symbol (includes the atomic number *and* mass number) for (1) an element with 7 protons and 8 neutrons; (2) an element with 26 protons and 30 neutrons; an element with 1 proton and 1 neutron. (Example  136C is the isotope symbol for an isotope of carbon with 6 protons and 7 neutrons)
4. Using a chemistry text or a web resource review nuclear chemistry and write the *equations* for four different nuclear reactions. Show all particles involved. One example should show alpha decay, one example should show beta decay, one example should show fission, and one example should show fusion.

B. Stellar chemistry and hydrogen fusion in stars: 1. What is the most abundant element in our universe?
2. What are the initial "starting" particles for nuclear fusion in stars?
3. Why would *neutral* *atoms* not be found in a star's interior? Describe the state in which the atoms exist in a star's interior.
4. Why can't molecules exist in a star?
5. What is the *overall* reaction for hydrogen nuclear fusion in stars?
6. Describe and show the 3 reactions depicting each step in the nuclear fusion in stars.
7. How is energy *created* in this process? Where did this energy come from? What famous equation relates to this process? In what form is the energy generated?
8. Since like charges repel each other, explain how two positive protons can fuse?
9. Where does hydrogen fusion occur in a star? Why does it not occur at the surface?
10. Compare the surface temperature of a star, such as the sun, with the its core temperature.
11. At about what minimum temperature does the core of a star need to be before fusion begins?
12. What are neutrinos? How are they produced? How do they interact with earth?

C.  The life cycle of stars 1. What is spectroscopy? How can this tool be used to identify the composition of stars and nebula?
2. What is a "molecular cloud"? What elements and compounds may be found in these clouds? What triggers the cloud to begin to collapse?
3. What is a "protostar"? What clears dust and gas around a protostar? (be sure to find the famous  Hubble Space Telescope image of the Gas Pillars which shows protostars)
4. What keeps a star from continually collapsing? What is meant by "*hydrostatic equilibrium*"?
5. Relate star color to temperature? Arrange the following star types from coolest to hottest: yellow, blue, orange, red.
6. Investigate the HR diagram. Draw a labeled sketch of this diagram. Be sure to label both axis and indicate the location of the main sequence, red giants, supergiants, white dwarfs, the sun, and neutron stars.
7. How can a supergiant be so large, but yet be relatively cool?
8. How can a supergiant be relatively cool, but be very luminous?
9. Arrange the following in the correct sequence to depict the life history of a star about the size of our sun:    red giant, main sequence, nebula, white dwarf, neutron star, protostar.
10. Explain how the life history of a star that is over 5 times the mass of our sun is different than the life history you depicted in the previous question.
11. Why is the Pleides called a "stellar nursery"?
12. Will our sun become a red giant or a supergiant? Why?
13. What will be the fate of our sun: white dwarf, neutron star, or black hole?
14. What will happen to the outer layers of the sun following the red giant stage? (hint: find info on planetary nebula)
15. What is a supernova? What type of stars may undergo a supernova? What exists after a supernova?
16. The Crab Nebula in the constellation Orion is the \_\_\_\_\_ of a supernova that was documented by the \_\_\_\_\_\_ about 1,000 years ago.
17. Give the name of a star in our night sky that is a supergiant. In what constellation is this star found?
18. What is the difference between neutron stars and black holes?

D. Creation of the elements 1. Following the Big Bang, the universe consisted almost entirely of which element?
2. Why does a star's hydrogen supply in the core eventually become depleted?
3. What would happen to a star if the hydrogen fusion process stopped and was not replaced by any other fusion processes?
4. *Copy and fill in the blanks*: When a star's core hydrogen supply gets low, \_\_\_\_\_\_\_   begins to fuse just outside the core. This is called \_\_\_\_\_ "burning". This process maintains the star's hydrostatic \_\_\_\_\_\_\_, and keeps it from collapsing. The star's size actually gets \_\_\_\_\_\_ at this stage and swells to the \_\_\_\_\_ stage.  The fusing of the helium with other light elements creates heavier elements such as carbon and \_\_\_\_\_\_ that did not exist before.
5. What element might be created when 2 helium nuclei fuse?
6. What two nuclei could fuse to form an oxygen-8 nuclide?
7. *Copy and fill in the blanks*: When an old-age star over 5 solar masses depletes its hydrogen supply, core temperatures can rise over 100 \_\_\_\_\_ degrees K. At these temperatures, heavier elements such as carbon and oxygen--created by helium burning--can now fuse with other nuclei  into *still* heavier elements such as neon, magnesium, silicon, sulfur, \_\_\_\_\_\_, \_\_\_\_\_\_, and \_\_\_\_\_.
8. *Copy and fill in the blanks*: These \_\_\_\_\_\_  reactions continue to build larger nuclei, until a very stable nucleus is created. This is the \_\_\_\_\_ nucleus. Even at the the incredibly high temperatures at the core of the supergiant, this nuclei is so stable it will not fuse with any other nuclei. This \_\_\_\_\_\_ (increases or decreases) the amount of energy the star can produce. Once a relatively significant amount of this element has built up in the star, the energy *output* cannot balance the *inward* \_\_\_\_\_ force. At this point, the star is no longer in hydrostatic \_\_\_\_\_\_ and it **collapses** producing a \_\_\_\_\_\_\_\_ implosion.
9. The temperatures produced during a \_\_\_\_\_\_implosion are so great that now, nuclei--including the stable \_\_\_\_\_  nuclei--built up before the implosion, can fuse to produce elements (nuclei) heavier than iron. All the \_\_\_\_\_\_ heavier than iron are thus created in these implosions.

E. Summary: "We are all star stuff!" 1. Consider a *carbon atom* that is part of a protein molecule in one of your blood cells. Could of this atom have been formed in a star *prior* to a supernova explosion?   Explain.
2. Consider a *silver atom* in a ring on your finger. How do you know that this atom was created during a supernova?
3. Consider a silicon atom found in a piece of granite rock. Through what stellar process was this atom most likely created?
4. As you have discovered, atoms are created in stars through complex processes throughout the life history of the stars. Are *new* atoms ever produced on earth? How?
5. Consider the periodic table. Which elements could be produced in stars similar to our sun in size? (just give the range of atomic numbers; for example: 4-12)
6. Again, consider the periodic table. Which elements (give the range of atomic numbers) could be produced by supernovas?
7. Consider the formation of our solar system from a nebula of gas and dust. What must have been the origin of this nebula? (Realize that this nebula must have contained heavier elements as there are heavy elements such as gold and lead that exist on some of the planets. )
8. Why can our sun be referred to as a  "*second generation star*"?
9. The astronomer Carl Sagan once stated that "**WE ARE ALL STAR STUFF"**. Write a brief essay to explain why this statement is true
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