

Worksheet # C15: Nuclear Chemistry

Directions: Skim through pages 700 - 721 of your textbook. Then go back and read more carefully, answering the following questions as you do.

I. The Nucleus

1. In the language of nuclear chemistry, what do you call

a. protons and neutrons? _____

b. atoms? _____

2. Review: What are isotopes? _____

Two atoms of carbon could be isotopes if they have the same number of _____ but different numbers of _____ in their nuclei.

What are the two ways you could represent an atom of carbon that has an atomic number of 6 (# of protons) and a mass number of 14 (#protons + # neutrons)?

_____ and _____

3. An amu is defined as one twelfth the mass of carbon-12, and is used to measure the masses of very small things. When amu's are used to measure the masses of a helium-4 atom and the parts that make up a helium-4 atom, they don't add up the same!

a. Which has the greater mass? _____

b. What is this difference called? _____

c. What causes the difference? _____

d. What famous equation says that mass can be converted to energy and vice versa?

e. What is the name of this energy that is released when protons and neutrons come together to form a nucleus? _____. This energy is also a measure of the _____

4. Flip back to page 74. What are nuclear forces? _____

a. Nuclear forces only work when the nucleons are very _____

b. Now go back to page 703 and consider figure 22-3. Protons A and B are attracted to each other because of the _____ but are repelled by each other because they both have a _____ charge. The _____ doesn't attract proton A to proton C because they are too _____. All they do is repel each other.

c. So having more _____ in a nucleus makes it more stable, because you increase the nuclear force without increasing the electrostatic (pos - pos) repulsion.

5. Define these two terms:

a. Nuclear reaction _____

b. Transmutation _____

II. Radioactive Decay

1. Define the following:

a. Radioactive decay _____

b. Nuclear radiation _____

2. Complete the following chart:

Type of nuclear radiation:	Symbol	Charge	What is necessary to stop it? (Figure 22-11 on pg 713)
Alpha particle			
		-1	
		+1	(not given)
Gamma ray			

Which of these: (give the symbol)

Is the biggest? _____ Is the smallest? _____ Are equal in mass? _____ and _____

3. The emissions:

- a. An alpha particle is basically a _____ nucleus and has a charge of _____
- b. A beta particle is just a fast moving _____ and has a charge of _____
- c. A positron is essentially a positive _____, and has a charge of _____
- d. Gamma rays are high energy _____ that come out of a nucleus as it changes from an _____ state to a _____ energy state. They generally accompany other types of _____ when the other types leave the nucleus in an _____.

4. Half-life

- a. Define half-life: _____

- b. Look at table 22-2.
 - i. Which element has the longest half-life? _____ What is it? _____
 - ii. Which element has the shortest half-life? _____ What is it? _____

III. Fission and Fusion (finally!)

1. Go to page 717 to define nuclear fission: _____

a. This process releases _____ amounts of _____. When uranium-235 is bombarded with slow _____, a uranium nucleus may _____ one of the _____, making it very _____. The nucleus splits into medium-mass parts (smaller atoms) with the emission of more _____ (which can go on to bombard other U-235's.) The mass of the products is less than the mass of the _____. The missing mass is converted to _____ (gulp!). Figure 22-14 shows the type of chain reaction that can occur if there is enough U-235 around (critical mass).

i. Define critical mass: _____

b. Nuclear reactors use _____ chain reactions to produce _____ or _____ nuclides (for research).

c. **Atomic bombs**, like those used in Hiroshima and Nagasaki in 1945, contain separated chunks of fissionable material such as U-235. When the bomb is detonated the chunks are pushed together to form a critical mass, which causes a fission chain reaction and a tremendous release of energy.

2. Go to page 719 to define nuclear fusion _____

a. Amazingly, nuclear fusion releases _____ per gram than nuclear _____. In our sun and in other stars, four _____ nuclei combine at extremely high _____ and _____ to form a _____ nucleus with a _____ of mass and _____ of _____,

b. **Hydrogen bombs** get their energy from uncontrolled _____ reactions of _____.

i. What kind of reaction is used to provide the heat and pressure to trigger the fusion reaction? _____

ii. What temperature (in degrees Kelvin) is required to induce a fusion reaction? _____

3. Nucleosynthesis Consider this article from NASA's web site: <http://helios.gsfc.nasa.gov/nucleo.html>

A star's energy comes from the combining of light elements into heavier elements in a process known as fusion, or "nuclear burning". It is generally believed that most of the elements in the universe heavier than helium are created, or synthesized, in stars when lighter nuclei fuse to make heavier nuclei. The process is called nucleosynthesis. Nucleosynthesis requires a high-speed collision, which can only be achieved with very high temperatures. The minimum temperature required for the fusion of hydrogen is 5 million degrees F. Elements with more protons in their nuclei require still higher temperatures. For instance, fusing carbon requires a temperature of about one billion degrees! Most of the heavy elements, from oxygen up through iron, are thought to be produced in stars that contain at least ten times as much matter as our Sun. Our Sun is currently burning, or fusing, hydrogen to helium. This is the process that occurs during most of a star's lifetime. After the hydrogen in the star's core is exhausted, the star can burn helium to form progressively heavier elements, carbon and oxygen and so on, until iron and nickel are formed. Up to this point the process releases energy. The formation of elements heavier than iron and nickel requires the input of energy. Supernova explosions result when the cores of massive stars have exhausted their fuel supplies and burned everything into iron and nickel. The nuclei with mass heavier than iron and nickel are thought to be formed during these explosions.

If this is true, all carbon-based life on Earth, including the body you live in, is literally composed of stardust.