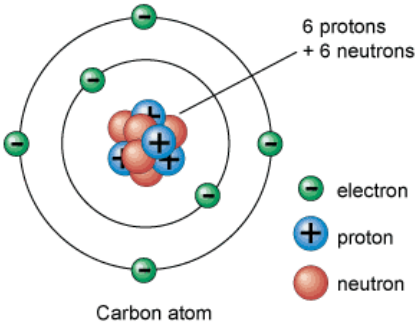
Big History Chemistry Study Guide **Name**_____

- **Atom:** smallest particle that still retains its chemical properties, (e.g. what it will react with)
- **Molecule:** two or more atoms bonded together ex: H_20, CO_2
- **Nucleus:**
  - contains protons & neutrons
  - Held together by the strong nuclear force
  - Surrounded by cloud of electrons
- **Protons**:
  - Positive charge
  - Mass of 1 a.m.u. ("atomic mass unit")
  - Found in the nucleus
- **Neutrons:**
  - Neutral (zero) charge
  - Mass of 1 a.m.u. ("atomic mass unit")
  - Inside nucleus; attract protons with strong nuclear force
- **Electrons:**
  - Charge of -1 (attracted to protons); TINY mass (.0005 a.m.u.)
  - Are found in "shells", "orbitals", or "clouds" surrounding the nucleus. Terminology depends on which model you choose to use. (Are actually in oddly-shaped clouds, but shells are easier to think about and draw.)
- **Ions**: Atoms which become charged by gaining or losing electrons (e^-)
  - PROTONS AND NEUTRONS STAY PUT unless there is a nuclear reaction, which affects the nucleus. Electrons, on the other hand, are frequently stripped from or added to atoms.
  - Gain electrons: become negative *anion*
  - Lose electrons: become positive *cation*
- **Isotopes**:
  - While there are usually a similar number of neutrons and protons, they definitely do not have to be equal. As you progress through the periodic table, the ratio changes from roughly 1:1 (Helium has 2 neutrons and 2 protons) up to roughly 1.5 : 1 (Mercury has 121 neutrons holding its 80 protons together)
  - Too many neutrons or not enough neutrons will result in a nucleus not being *stable*. This means it will not survive in that form, and will split apart in a nuclear fission reaction, breaking into smaller elements. Elements that are unstable are called radioactive, because they actively release radiation (which can harm or kill you). Naturally radioactive elements include Radon, Uranium, and Plutonium
  - The various forms of one element with different numbers of neutrons are called *isotopes.*



Carbon atom

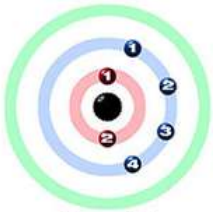


Figure 3A
Classical Atomic
Schematic of Carbon

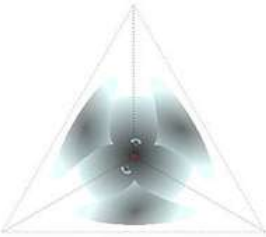
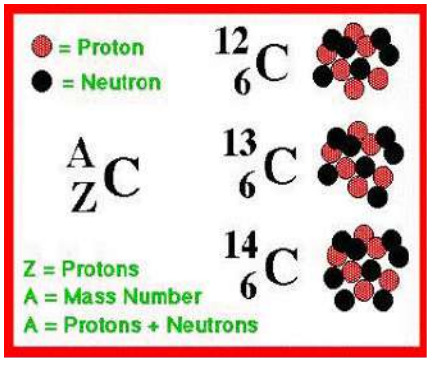
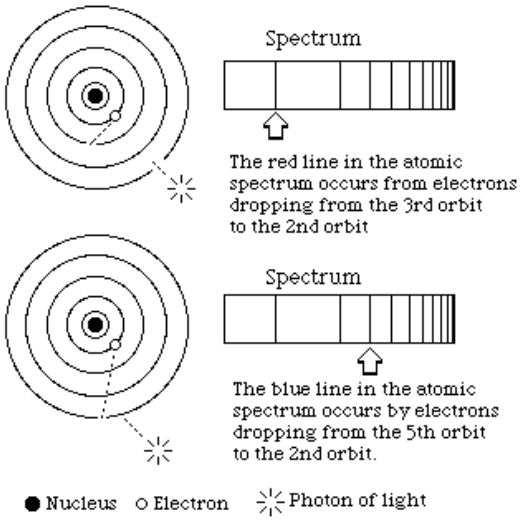


Figure 3B
New Atomic Schematic of Carbon

The three isotopes of carbon: all isotopes of an element have the same number of protons and electrons. They vary in the number of neutrons present in the nucleus, and therefore they vary in mass. Isotopes are named based on their masses ("carbon-12, carbon-13, carbon-14").



- **A FEW Important Bits of History**:
  - Democritus, 400 BCE: concept of indivisible little bits called "atoms"
  - Aristotle, ca. 350 BCE: Concept of all matter being combinations of just 4 elements (earth, air, water, fire)
  - John Dalton, 1804: First good atomic theory.
    - All atoms of a certain element are identical.
    - Atoms of different elements are different.
    - Chemical reactions just rearrange atoms, but do not create or destroy them.
  - Dmitri Mendeleev, 1869:
    - Noticed a repeating, periodic, pattern in the properties of elements as he arranged them by atomic mass.
    - Arranged these in a table. A periodic table!
  - Rutherford, 1910: Discovered the nucleus by beaming positive particles through extremely thin gold foil, and noticing that most of the particles went straight through (empty space, electron cloud) but a very few of them bounced back, because they had hit a tiny positive center (the nucleus)
  - Niels Bohr, 1912:
    - Electrons can orbit only at certain allowed distances from the nucleus. (Quantum theory)
    - Atoms radiate energy (give off photon) when an electron jumps from a higher-energy orbit to a lower-energy orbit. Also, an atom absorbs energy when an electron gets boosted from a low-energy orbit to a high-energy orbit.



  - Henry Moseley, 1916:
    - Confirms experimentally that there are protons in the nucleus, and that the atomic number is equal to the number of protons.
    - Predicts new elements to be discovered, based on missing atomic numbers.

Name _____ Date _____ Block _____

1. Atoms are normally electrically neutral, because they have the same number of _____ and _____.

2. If an atom loses an _____, it will be left with more _____ than _____, and will have a _____ charge. It will now be a _____ _____.

3. The atom is composed mostly of empty _____. Almost all of the mass of the atom (>99%) is located in the _____, made of _____ and _____.

4. Atoms are placed in the periodic table in order of _____ _____, which equals the number of _____. The person who gets credit for this concept, and the first version of the table, is _____ _____.

5. The atomic mass is equal to the _____ plus _____.

6. Every atom of _____ in the universe has 5 protons. The atomic mass of this element is listed as _____ amu, which means that its most common isotopes have masses of _____ and _____. These isotopes have _____ neutrons or ____ neutrons.

7. In nuclear _____, small atoms combine to make larger atoms, losing a tiny bit of mass and releasing energy in the process.

8. In nuclear _____, radioactive elements such as _____ break apart into smaller elements ("decay products"), also releasing energy.

9. The significance of Henry _____'s experiment with x-rays and atoms is that it found a numerical relationship between the _____ of light produced by an atom and the _____ number of an atom. He was able to predict certain _____ which should be in the periodic table, based on the atomic number, but had not been discovered yet.

10. A column in the periodic table consists of elements which have similar _____ _____. As you progress down a column in the periodic table, the atomic mass _____.

Short Answer:

11. Why are the atomic masses in the periodic table not whole numbers?

12. Why are would Carbon-8 be very unstable?