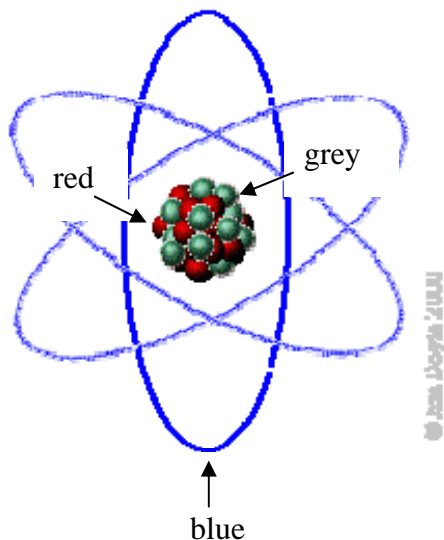


Figure 1 was designed to represent an atom. Critique the model by answering the following questions:

Figure 1: Representation of an Atom



1) What are the red and grey spheres in the middle supposed to represent?

Protons and neutrons.

2) What are the blue ovals supposed to represent?

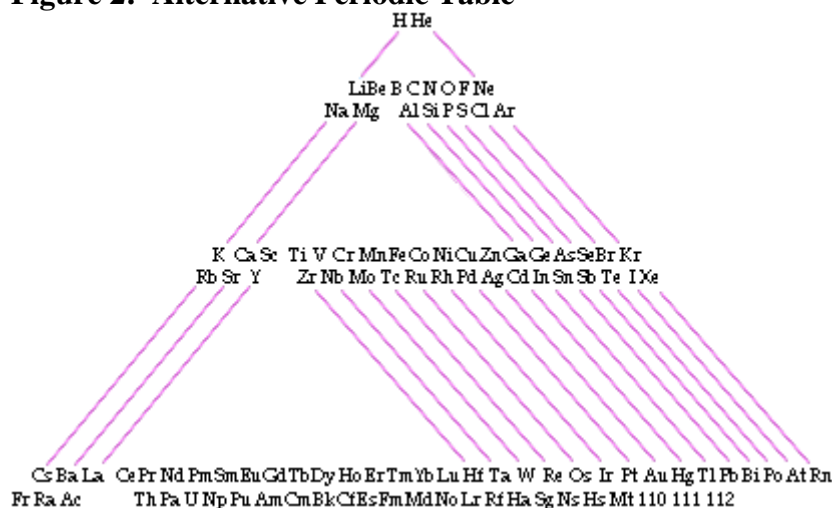
The path of electron movement.

3) Describe at least three ways in which this drawing misrepresents an atom.

The size of the nucleus as compared to the size of the region the electrons occupy.
Electrons don't move in orbits.
The width of the blue lines are far too large to represent the size of the electron.
The particles are not colored (to the best of our knowledge).

An alternative periodic table is shown in Figure 2:

Figure 2: Alternative Periodic Table



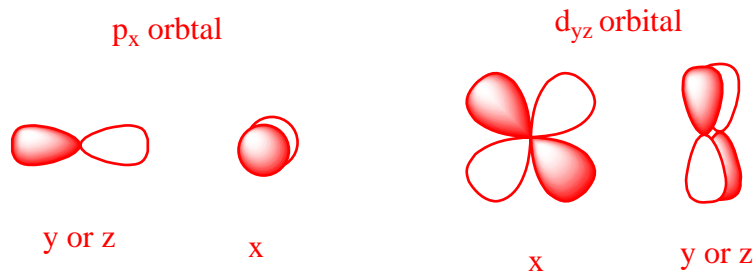
4) Write 1-2 sentences describing how this table is assembled.

The horizontal rows contain all elements with the same principle quantum number. The diagonal lines represent the comparable electrons filling for both the principle quantum number (n) and angular momentum quantum number (l).

5) Write 2-3 sentences advocating for either this table (the triangle table) or the traditional periodic table (found in your book) as easier to use.

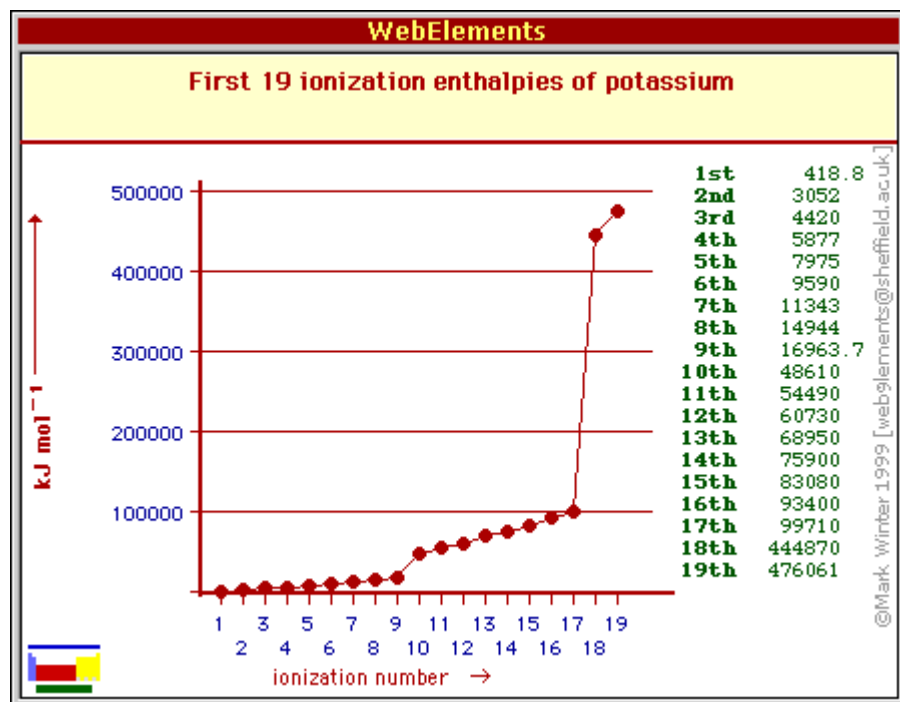
The triangle table is superior in showing the relationships between atoms. However, periodic tables typically contain a lot of information such as electronegativity, density, atomic weight, common oxidation states etc. The triangle table is not as compact and would be unwieldy to place in a book or on a piece of paper carrying the same density of information.

6) Draw pictures showing how the p_x , and d_{yz} orbitals look when viewed along the x , y , and z axes (some views may look the same).



7) Figure 3 shows the nineteen ionization energies of potassium

Figure 3: Potassium ionization energies¹



a) Write the chemical equation for the fifth ionization of potassium.



b) Explain the large jumps in ionization energy between the 9th and the 10th and the 17th and the 18th.

The jump between the 9th and 10th represents a change from ionizing n=3 electron to ionizing n=2 electrons. The jump between the 17th and 18th represents a change from ionizing n=2 electron to ionizing n=1 electrons. The principle quantum number (n) is the single greatest determinant of an electron's energy.

8) In class, you saw the reaction of potassium with water? Is this chemical reaction represented in Figure 3? If so, where?

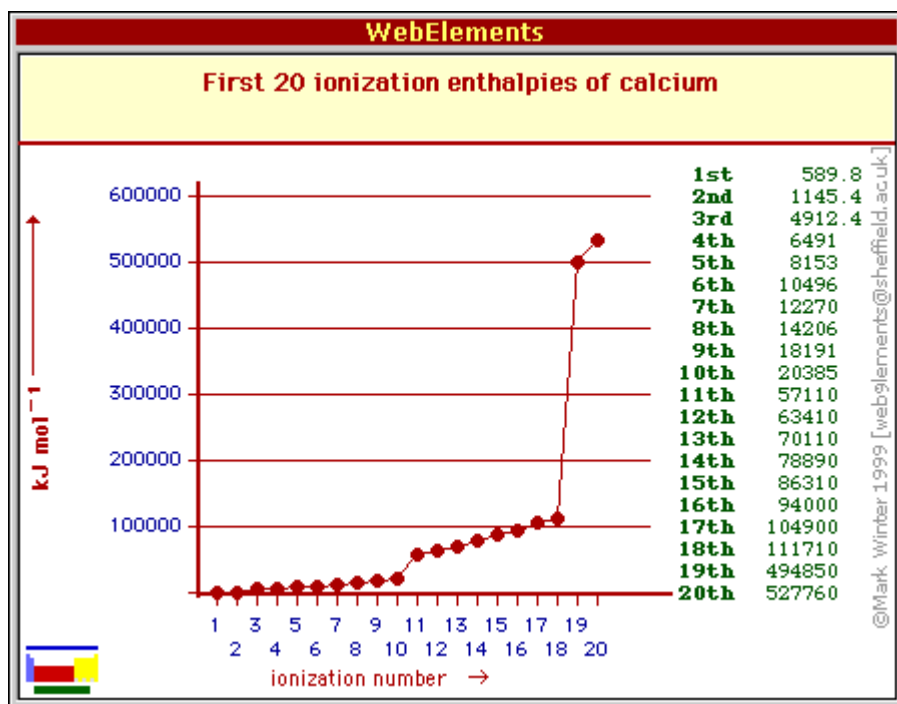
This reaction does involve the 1 e- oxidation of K metal to K+ ion. This is related to the first ionization potential.

¹ Webelements <http://www.webelements.com/webelements/elements/text/K/ionz.html> (Accessed September 2006)

9). Is the first ionization energy of calcium higher or lower than that of potassium? Why?

The first ionization energy of calcium is higher. All things being equal, for the addition of a proton and an electron the increase in effective nuclear charge is greater and the electron is more tightly held. This causes the atomic radius to decrease and the first ionization energy to increase. (Note, the principle or angular momentum quantum number changes this will cause deviations in the trend).

10) Sketch a graph showing the twenty ionization energies of calcium, labeling any large increases.



Moore, Stanitski, and Jurs: Chapter 2: 82, 88, 112;

Chapter 7: 49, 51, 65, 95, 103, 109, 127, 137

Chapter 2:

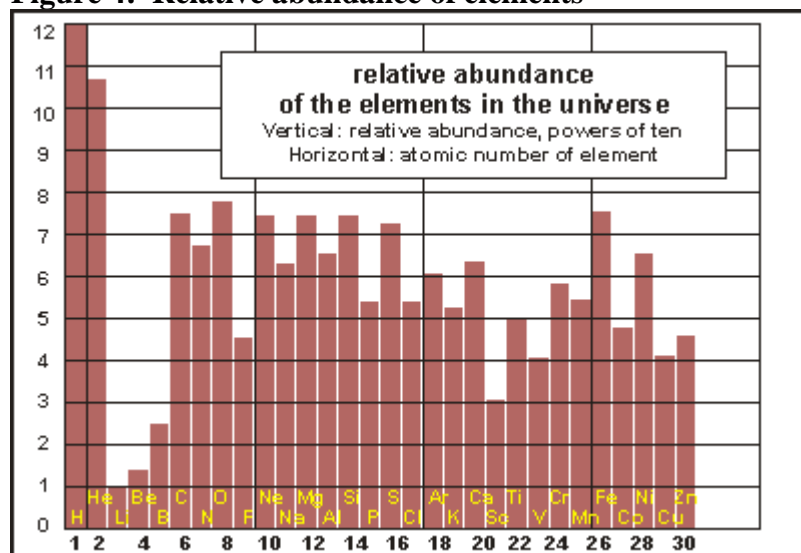
82) How many elements are there in Group 4A of the periodic table? Give the name and symbol of each of these elements. Tell whether each is a metal, metalloid, or nonmetal.

Element	Abbreviation	Type
Carbon	C	Non-metal
Silicon	Si	Metalloid
Germanium	Ge	Metalloid
Tin	Sn	Metal
Lead	Pb	Metal

88) The following chart is a plot of the logarithm of the relative abundances of elements 1 through 36 in the solar system. The abundances are given on a scale that assigns silicon a relative value of 1.00×10^6 (the logarithm of which is 6).

- What is the most abundant metal?
- What is the most abundant nonmetal?
- What is the most abundant metalloid?
- Which of the transition elements is most abundant?
- How many halogens are considered on this plot, and which is most abundant?

Figure 4: Relative abundance of elements²



The most abundant metal is magnesium (Mg).

The most abundant non-metal is hydrogen.

The most abundant metalloid is silicon.

Iron is the most abundant transition metal

Fluorine and Chlorine are the two halogens included. Chlorine is more abundant.

² <http://www.seafriends.org.nz/oceano/ocean23.gif> (Accessed September 2006)

112) A group of astronauts in a spaceship accidentally encounters a space warp that traps them in an alternative universe where the chemical elements are quite different from the ones they are used to. The astronauts find these properties for the elements they have discovered:

Atomic Symbol	Atomic Weight	State	Color	Electrical Conductivity	Electrical Reactivity
A	3.2	Solid	Silvery	High	Medium
D	13.5	Gas	Colorless	Very low	Very High
E	5.31	Solid	Silvery	Very high	Medium
G	15.43	Solid	Silvery	High	Medium
J	27.89	Solid	Colorless	High	Medium
L	21.57	Liquid	Colorless	Very low	Medium
M	11.23	Gas	Colorless	Very low	Very low
Q	8.97	Liquid	Colorless	Very low	Medium
R	1.02	Gas	Colorless	Very low	Very High
T	33.85	Solid	Colorless	Very low	Medium
X	23.68	Gas	Colorless	Very low	Very low
Z	36.2	Gas	Colorless	Very low	Medium
Ab	29.85	solid	golden	Very high	Medium

a) Arrange these elements into a periodic table.

R 1.02 G C VL VH	A 3.2 S S H M	E 5.31 S S V H M		Q 8.97 L C VL M	M 11.23 G C VL VL
D 13.5 G C L VH	G 15.43 S S H M			L 21.57 L C VL M	X 23.68 G C VL VL
X 25.84 G C L VH	J 27.89 S C H M	Ab 29.85 S G V H M		T 33.85 S C VL M	Z 36.2 G C VL M

b) If a new element, X, with atomic weight 25.84 is discovered, what would its properties be? Where would it fit in the periodic table you constructed?

Placed in table above using blue electrons. We predict it to be a colorless gas with low electrical conductivity and high electrical reactivity.

c) Are there any elements that have not yet been discovered? If so, what would their properties be?

This table has room for four more elements. The element in column three is expected to have a mass of ~17.5 and be a metallic, highly conducting solid. The elements in column 4 are a little less certain. The third row element would likely be a solid but the physical properties are easily predicted. The first and second row elements may be a liquid or a solid and the electrical properties are not certain.

Chapter 7:

49) Assign a set of four quantum numbers for:

a. Each electron in a nitrogen atom

$$n = 1, l = 0, m_l = 0, m_s = +1/2$$

$$n = 1, l = 0, m_l = 0, m_s = -1/2$$

$$n = 2, l = 0, m_l = 0, m_s = +1/2$$

$$n = 2, l = 0, m_l = 0, m_s = -1/2$$

$$n = 2, l = 1, m_l = 0, m_s = +1/2$$

$$n = 2, l = 1, m_l = 1, m_s = +1/2$$

$$n = 2, l = 1, m_l = -1, m_s = +1/2$$

The values of m_s were chosen to be the same to follow Hund's rule and the get lowest energy arrangement. This forced me to choose three different values of m_l .

b. The valence electron in a sodium atom

$$n = 3, l = 0, m_l = 0, m_s = +1/2$$

c. A 3d electron in a nickel atom

$$n = 3, l = 2, m_l = 0, m_s = +1/2$$

50) One electron has the set of quantum numbers, $n = 3, l = 1, m_l = -1$ and $m_s = +1/2$; another electron has the set $n = 3, l = 1, m_l = 1$, and $m_s = +1/2$.

a. Could the electrons be in the same atom? Explain

Yes, the set of four quantum numbers differs (1 vs -1 for m_l).

b. Could they be in the same orbital? Explain

No, m_l specifies a different orientation of the orbital.

65) Write the electron configurations for these atoms.

a) Strontium (Sr), named for a town in Scotland



b) Tin (Sn), a metal used in the ancient world. Alloys of tin (solder, bronze, and pewter) are important



95) Select the atom or ion in each pair that has the larger radius.

a) Cl or Cl^-

b) Ca or Ca^{+2}

c) Al or N

d) In or Sn

e) Cl^- or K^+

103) Compare the elements Li, K, C, N

a) Which has the largest atomic radius? **K**

b) Place the elements in order of increasing ionization energy. **$\text{K} < \text{Li} < \text{C} < \text{N}$**

109) Which group of the periodic table has elements with high first ionization potentials *and* very negative electron affinities? Explain this behavior.

The halogens. For a given row they have among the highest effective nuclear charges causing the radius to be small and the ionization energy to be large. However, they are one electron short of containing a full octet and so readily gain an electron to become a negatively charged ion.

127) Classify these statements as being either true or false. If a statement is false, correct it to make it true.

a) A 3f orbital can hold a maximum of 14 electrons **False; no 3f orbital**

b) The ground state electron configuration of a sulfur atom is $1s^2 2s^2 2p^6 3s^2 3p^4$. **True**

c) A ground state sulfur atom has four unpaired electrons. **False. Sulfur has four electrons present in the 3p orbitals. Two of the electrons must pair leaving only two unpaired electrons.**

d) A Mg^{+2} ion has an argon electron configuration. **False. Mg^{+2} has a neon electron configuration.**

e) An N^{-3} ion and a P^{-3} ion have the same ground-state electron configuration. **False. They have the same number of valence electrons but differ in their total number of electrons.**

137) Write the formula for the compound that most likely forms between potassium and element Z if element Z has the electronic configuration $1s^2 2s^2 2p^6 3s^2 3p^4$.

K_2Z