Matter and Motion Fall 2015

Chemistry Workshop 2

The workshop is intended to be a low-pressure setting where we get to practice problems, ask any questions, and discuss concepts and problem solving methods. Have fun! Work together on whiteboards or scratch paper and then neatly write your solutions in the notebook where you keep chemistry class notes. Your workshop solutions will be included in your portfolio. Starting this week, workshop solutions will be posted on the class website for you to use while studying.

1. Use the orbital box notation to give the full electronic configuration for the ground state of iron metal. What are acceptable quantum numbers for its highest energy electrons? Discuss how Hund's rule and the Pauli Exclusion Principle apply here.

1s	2s	2p	3s	3p	4s	3d
↑↓	↑↓	↑↓↑↓↑↓	↑↓	↑↓↑↓↑↓	↑↓	↑↓↑ ↑ ↑ ↑

Acceptable Quantum Numbers are n=3, l=2, ml=-2,-1,0,1,2; ms=±1/2

Hund's Rule applies here because we filled the d shell halfway before adding the 6th electron, the one being the downward pointing electron.

The Pauli Exclusion Principle applies here because each electron occupying an orbital with another electon would be designated with a ±1/2 charge to differentiate them. This notation is used because only one electron can have a given set of quantum numbers, so the ±1/2 gives 2 spaces that can be occupied per orbital.

3. Write the electron configuration using the noble gas notation for:

a) Sn

[Kr] $5s^2 4d^{10} 5p^2$

b) V

[Ar] $4s^2 3d^3$

Start with the noble gas one period higher than the electron configuration you'll be writing and just follow the orbital pattern.

5. It is claimed that subshells half-filled with electrons are particularly stable. Discuss the physical basis for this claim.

Half-filled subshells are more stable due to an equidistant distribution of electrons throughout the orbital. This is due to the negative charge of electrons that causes them to repulse each other. For example, 3 electrons in the p orbitals will be more evenly spaced than adding a 4th electron that will have to occupy one of the 3 subshells in that orbital.

7. Mars is roughly 60 million km from Earth. How long does it take for a radio signal originating from Earth to reach Mars?

Since radio signals travel at the speed of light, our conversion factor will be that.

$$\frac{60 \text{ million km}}{} \times \frac{1 \text{ s}}{299{,}792{,}458 \text{ m}} \times \frac{1000 \text{m}}{1 \text{ km}} = 200 \text{ s}$$

9. Assume that we are in another universe with different physical laws. Electrons in this universe are described by four quantum numbers with meanings similar to those we use. We will call these quantum numbers p, q, r, and s. The rules for these quantum numbers are as follows:

P = 1, 2, 3, 4, 5, …

q takes on positive odd integers and $q \leq p$

r takes on all even integer values from $-q$ to $+q$. (including zero)

s= +1/2 or -1/2

a. Sketch what the first four periods of the periodic table will look like in this universe.

b. What are the atomic numbers of the first four elements you would expect to be least reactive?

c. How many electrons can have p = 4, q = 3?

d. How many electrons can have p = 3, q = 0, r = 0?

To start with this problem we'll be applying these new rules as what the quantum numbers are in our universe, so n becomes p, l becomes q, ml becomes r, and ms becomes s. Given the current conditions our periods will look something like this:

a.

1st period: p = 1; q = 1; r = 0; s = ±1/2

2nd period: p = 2; q = 1; r = 0; s = ±1/2

3rd period: p = 3; q = 1, 3; r = -2, 0, 2; s = ±1/2

4th period: p = 4; q = 1, 3; r = -2, 0, 2; s = ±1/2

So our new table would look something like this

[1] [2]

[3] [4]

[5] [6] [7] [8] [9] [10] [11] [12]

[13] [14] [15] [16] [17] [18] [19] [20]

b.

The atomic numbers of the first four least reactive elements would be located in a similar region as our periodic table with all of them occuring at the end of their respective rows, so they would be *<u>2, 4, 12, and 20.</u>*

c.

The total electrons a $p = 4$*,* $q = 3$ *would be 2 because of the* $\pm 1/2$ *that occurs at each orbital.*

d.

$q = 0$ *can not exist under these rules so there are no electrons that exist there.*