Name: _____ Chem 10, Section: _____

Lab Partner: _____ Experiment Date: _____

Flame Tests of Metal Cations

Experimental Data and Observations

Solution	Dominant Flame Color	Wavelength (nm)
LiCl		
NaCl		
KCl		
$CuCl_2$		
$BaCl_2$		
$CaCl_2$		

Data Analysis

Using the wavelengths recorded above, calculate the corresponding frequencies and photon energies for the emitted radiation observed for each compound tested. Record the results of your calculations in the table below.

Solution	Wavelength (m)	Frequency (s^{-1})	Photon Energy (J)
LiCl			
NaCl			
KCl			
$CuCl_2$			
$BaCl_2$			
$CaCl_2$			

Show a set of sample calculations for LiCl only below. Clearly show any equations you have used.

- Wavelength (in m):

- Frequency (in s^{-1}):

- Photon Energy (in J):

Questions

1) Complete the following paragraph by circling the correct responses:

In this experiment, the metal cations in the solutions were initially in the (ground, excited) state. When placed in the flame, the metals then (absorbed, emitted) energy as (electricity, heat, EM radiation). When this occurred, electrons made transitions from (low, high) energy levels to (low, high) energy levels. The metals were then in the (ground, excited) state. The electrons in these metals then made transitions from (low, high) energy levels to (low, high) energy levels, resulting in the (absorption, emission) of energy as (electricity, heat, EM radiation).

2) What evidence is there that the colors observed in the flame tests are due to the metals, and not the nonmetals in the compounds tested?

3) Which metal cation was observed to emit radiation with the *shortest* wavelength? _____

Compared to the other metals studied, did the radiation emitted by this metal cation (identified above) have

- the highest or lowest frequency? _____
- the highest or lowest photon energy? _____

From this, would you conclude that the relationships between the following are direct or inverse?

- wavelength and frequency _____
- frequency and photon energy _____
- wavelength and photon energy _____

4) The energy, wavelength and frequency of an emitted photon are all related to the size of the electronic transition (high $\rightarrow$ low energy levels) occurring in the metal cation. Based on your observations, in which metal did the *smallest* electronic transitions occur? Briefly explain your response.

5) When heated in a flame, the element Indium emits electromagnetic radiation with a distinctive indigo blue color (the name indium is derived from the word indigo). The emitted photons that give rise to this color have energies of 4.405×10^{-19} J. Calculate the wavelength of this radiation in *nanometers*.

Exercise

In the Bohr Model of the atom, electrons occupy fixed orbits around the nucleus called energy levels. However in the Quantum Mechanical Model of the atom, electrons occupy orbitals. Orbitals are grouped by size and shape into shells and subshells (or, levels, and sublevels). Electron configurations and orbital diagrams are used to show the arrangement of electrons in shells (levels), subshells (sublevels) and orbitals for specific atoms.

Write complete electron configurations and abbreviated orbital diagrams for each of the elements given below. Circle the valence electrons in your complete electron configurations.

Chlorine

complete configuration: _____

abbreviated orbital diagram:

Tin

complete configuration: _____

abbreviated orbital diagram:

Selenium

complete configuration: _____

abbreviated orbital diagram:

Cobalt

complete configuration: _____

abbreviated orbital diagram:

Boron

complete configuration: _____

abbreviated orbital diagram:

Bismuth

complete configuration: _____

abbreviated orbital diagram:

Magnesium

complete configuration: _____

abbreviated orbital diagram: