Unit 1 FRQ Set #1 – Answer Key

HOW TO GRADE THESE…

- **Each box is worth 1 point**
  - In order to earn the point all statements must be present (if missing anything at all no point should be awarded)
  - Opposite arguments are fine and will still earn points
    - For example:

      saying Be has a smaller radius than Li

      is the same as

      saying Li has a larger radius then Be

- **Assign points with a different color than what you did the original problem with**
  - If you think you have to ask Mr. Doolan if you are going to earn a point for something just mark it wrong and make the correction… really, really!

- **Make corrections with a 3rd ink color that is different from the others so that they will stand out.**
  - PLEASE, PLEASE, PLEASE!!!!!!!
    - Make sure you understand WHY any parts you left out are essential to complete the argument

Part 1:

6a.)

Evidence:

- Li has valence electrons (VE) in 2s energy shell, 2 core electrons (e^-) involved in shielding
- Be has VE in 2s energy shell, 2 core e^- involved in shielding
- Li has 3 protons (p+) and Be has 4 p+
- Atomic radius – measure of the distance between the nucleus and the outermost valence electron

Claim:

Be has a smaller atomic radius than Li because:

- VE for both elements are in the same shell and shielding is constant
- Therefore Coulombic attraction is determined by the number of p+
- Be has 1 more p+, higher Coulombic attraction, so VE pulled closer to nucleus making radius smaller

6b.)

Evidence:

- 2^{nd} ionization energy (IE) is the removal of the second least tightly held electron (e^-)
- $K^+ = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$, 3p e^- removed in 2^{nd} ionization
- $Ca^+ = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1$, 4s e^- removed in 2^{nd} ionization
- K^+ has 10 core e^- involved in shielding
- Ca^+ has 18 core e^- involved in shielding

Claim:

K^+ has a greater 2^{nd} IE because:

- 4s energy shell further from nucleus and has more shielding than 3p energy shell
- Which means K^+ has higher Coulombic attraction for 3p e^- and requires more energy to remove the e^-

Part 2:

7a.)

Evidence:

- $Ca^{2+} = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$
- $Cl^- = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$
- Valence electrons (VE) for both ions are in 3rd energy shell and shielding is constant
- Ca^{2+} has 20 protons (p+) and Cl^- has 17 p+
- Atomic radius – measure of the distance between the nucleus and the outermost valence electron

Claim:

Cl^- has a larger radius than Ca^{2+} because:

- VE for both ions are in the 3rd energy shell and shielding is constant
- Therefore Coulombic attraction is determined by the number of p+
- Ca^{2+} has 3 more p+, higher Coulombic attraction, so VE pulled closer to nucleus making radius smaller

7d.)

Evidence:

- First ionization energy (IE) is the removal of the least tightly held valence electron (VE) from a gaseous state element
- $Be = 1s^2\ 2s^2$
- $B = 1s^2\ 2s^2\ 2p^1$
- VE removed for Be is from 2s
- VE removed for B is in 2p
- 2 core electron (e^-) involved in shielding for both Be and B

Claim:

B has a lower 1st IE than Be because:

- 2p energy shell is slightly higher in energy than 2s because of orbital shapes
- For the 1st p electron this reduces Coulombic attraction (CA) slightly
- Therefore B has a slightly lower CA than B that would be predicted by 1st IE trends which leads to a slightly reduced 1st IE

Part 3:

7a.)

Evidence:

- Atomic radius – measure of the distance between the nucleus and the outermost valence electron (VE)
- VE across period from Na to Cl are in 3rd energy shell
- Shielding is constant across period from Na to Cl
- Protons (p+) increase across period from Na to Cl

Claim:

Atomic radius decreases across the period from Na to Cl because:

- VE for elements from Na to Cl are in the 3rd energy shell and shielding is constant
- Therefore Coulombic attraction is determined by the number of p+
- p+ increase from Na to Cl, Coulombic attraction increases from Na to Cl, so VE pulled closer to nucleus making radius smaller as we move from Na to Cl

7c.)

Evidence:

- First ionization energy (IE) is the removal of the least tightly held valence electron (VE) from a gaseous state element
- VE removed for K is from 4s and VE removed from Na is in 3s
- 18 core electron (e^-) involved in shielding for 4s e^- in K and 10 core e^- involved in shielding for 3s e^- in Na

Claim:

1st IE of K is less than Na because:

- 4s energy shell is higher in energy and further from nucleus than 3s energy shell
- 4s energy shell in K has higher shielding than 3s energy shell in Na
- Which makes Coulombic attraction (CA) to 4s e^- in K lower than CA to 3s e^- in Na
- Therefore less energy is required to ionize the 4s e^- in K

7d.)

Evidence:

- Emission spectrums are caused when electrons (e^-) that have absorbed a quanta of energy return back to ground state and release the absorbed quanta of energy in the form of Electromagnetic (EM) radiation
- Every element has a unique atomic structure

Claim:

Each element displays a unique gas-phase emission spectrum because:

- Each element will have a unique energy associated with its electrons based upon coulombic interactions between the nucleus and electrons
- Therefore the quanta of energy absorbed and thereby released will be unique for each element creating a unique emission spectrum