Chem 130, Eppley Name:

Spring 2015

In Class Assignment 5
Periodic Properties

Explain the following statement as clearly and as thoroughly as you can. **Use diagrams, elelctron configurations, etc. to support your answers whenever possible.**

1. Lithium has a higher ionization energy than sodium but a lower ionization energy than beryllium.

Li > Na
Li < Be

Lithium has a higher ionization energy than Na because it has electrons in the n=2 principal quantum level, so they would be closer to the nucleus and therefore more difficult to remove than the n=3 outermost e⁻ of Na. Lithium has a lower Zeff than Be due to fewer p⁺ but the same # of shielding e⁻ ∴ the e⁻ in lithium are less strongly attracted to the nucleus

2. Titanium is smaller than scandium and calcium is smaller than potassium. However, there is a smaller size **difference** between titanium and scandium than between calcium and potassium.

Ti < Sc
Ca < K

Ti has more p⁺ and a higher Zeff than Sc. Similarly, Ca has more p⁺ and a higher Zeff than K. Higher Zeff means that the e⁻ are pulled in more tightly, resulting in a smaller atom. The size difference is less for Ti and Sc because Zeff changes more slowly across the d-block than across the s and p block. This is because the added e⁻ are in the n-1 quantum level, so they partially shield the outermost e⁻ from the increased charge in the nucleus, therefore Zeff increases much less than +1 per element

3. The size of Cd^{2+} is smaller than that of Nb^{2+} but it is also smaller than Sn^{2+}

Cd^{2+} [Kr] $4d^{10}$
Nb^{2+} [Kr] $4d^3$
Sn^{2+} [Kr] $5s^2 4d^{10}$

The number of p^+ increases from Nb to Cd^{2+} to Sn^{2+}. Since Nb^{2+} and Cd^{2+} both have their outermost e⁻ in the n=4 (4d) orbital, Cd's higher Zeff makes it smaller. However Sn^{2+} still has e⁻ in its n=5 quantum level. These e⁻ are further from the nucleus so the atom is bigger!