General Chemistry 1210
Midterm 3 Comprehensive Guide with Practice Problems

Each topic is the focus of a slide from the lecture power points. The following problems are compiled mainly from the text and mastering chemistry based off of the main topics covered in lecture and emphasized through professor-assigned homework. The order based on the sequence of what was taught in lecture. Correct answers listed below each respective practice problem. This guide utilizes concepts and practice problems from Mastering Chemistry, "Chemistry: The Central Science" by Theodore L Brown, and lecture slides from Professor Gustafson. Any of their work shown here is copyrighted and belongs to them respectively. I do not own any of this information.

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Topic #1: Effective Nuclear Charge section 7.2 page 251 in text

Effective nuclear charge, Zeff, is defined as

$$Zeff = Z - S$$

where Z is true nuclear charge and S is the amount of shielding.
In 1930, John C. Slater devised the following set of empirical rules to estimate S for a designated ns or np electron:
Write the electron configuration of the element, and group the subshells as follows: (1s), (2s, 2p), (3s, 3p), (3d), (4s, 4p), (4d), (4f), (5s, 5p), and so on.
Electrons in groups to the right of the (ns, np) group contribute nothing to the shielding constant for the designated electron.
All the other electrons in the (ns, np) group shield the designated electron to the extent of 0.35 each.
All electrons in the n−1 shell shield to the extent of 0.85 each.
All electrons in the n−2 shell, or lower, shield completely—their contributions to the shielding constant are 1.00 each.
When the designated electron is in an nd or nf group, rules (i), (ii), and (iii) remain the same but rules (iv) and (v) are replaced by the following:
Each electron in a group lying to the left of the nd or nf group contributes 1.00 to the shielding constant.
These rules are a simplified generalization based on the average behavior of different types of electrons.

Practice

1. Calculate Zeff for a valence electron in an oxygen atom.
   4.55

2. Calculate Zeff for the 4s electron in a copper atom, Cu.
   3.70

3. Calculate Zeff for a 3d electron in a copper atom, Cu.
   7.85

Topic #2: Periodic Trends in Atomic Radii section 7.3 page 255 in text

Within each group, bonding atomic radius tends to increase from top to bottom. This trend results primarily from the increase in the principal quantum number (*n*) of the outer electrons. As we go down a column, the outer electrons have a greater probability of being farther from the nucleus, causing the atomic radius to increase. Within each period, bonding atomic radius tends to decrease from left to right. The major factor influencing this trend is the increase in effective nuclear charge Zeff across a period. The increasing effective nuclear charge steadily draws the valence electrons closer to the nucleus, causing the bonding atomic radius to decrease.