Guide to Chapter 6. Ionic Bonding

We will spend about 1 1/2 lecture days covering just the first five sections of this chapter (just 10 pages). In this chapter we will learn more about ionic bonding. We will learn more about shielding, effective nuclear charge, and some more periodic trends including ion size, ionization energy, and electron affinity. I will summarize the main ideas (qualitative, not quantitative) in Section 6, but you do not need to read that section.

This is a chapter study guide, given section-by-section. Work problems on separate sheets of paper and keep them with this guide. When working problems, use plenty of space and when appropriate, show all work.

☐ **Read the introductory paragraph to Chapter 6.**

☐ **Read Section 6.1 Ions and their Electron Configurations.**

☐ ☐ Learning Objective 1: Know how to write the electron configuration for any ion.

☐ ☐ Learning Objective 2: Know that the transition metals lose electrons from their ns orbitals before the (n-1)d orbitals.

☐ Do Problem 1-2 at the end of the section.

☐ Do the following end-of-chapter problems: 30, 36, 38,

☐ *Problem Club Question A. Write the electron configuration for each of the following ions: (a) Fe^{+2}; (b) Fe^{+3}; (c) Ni^{+2}; (d) Cr^{+3}; (e) Zn^{+2}*

Answers: (a) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^0\ 3d^6$ or [Ar] $4s^0\ 3d^6$
(b) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^0\ 3d^5$ or [Ar] $4s^0\ 3d^5$
(c) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^0\ 3d^8$ or [Ar] $4s^0\ 3d^8$
(d) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^0\ 3d^3$ or [Ar] $4s^0\ 3d^3$
(e) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^0\ 3d^{10}$ or [Ar] $4s^0\ 3d^{10}$

☐ *Problem Club Question B. Which of the following is/are paramagnetic?*

(a) Mn (b) Zn (c) Sn

Answers: (a) and (c)

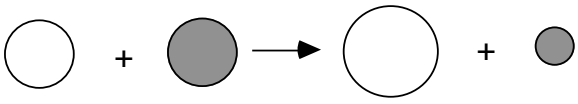
☐ **Read Section 6.2 Ionic Radii.**

☐ ☐ Learning Objective 3: Know how ionic radii compare with atomic radii.

☐ Do Problems 3 and 4 at the end of the section.

☐ *Problem Club Question C. In this representation, a metal and non-metal react. Which identification is most likely correct?*

(a) the non-shaded circle is the metal
(b) the shaded circle is the metal
(c) the anion is the smaller shaded circle
(d) the cation is the larger open circle
(e) these are all likely descriptions



Answers: (b)

☐ *Problem Club Question D. Arrange these elements in order of increasing first ionization energies: (a) Rb, Sn, I and Xe; (b) Si, Ge, and Sn; (c) Na, Mg, S, or Ar*

Answers: (a) Rb < Sn < I < Xe; (b) Sn < Ge < Si; (c) Na < Mg < S < Ar

☐ *Problem Club Question E. Which has the smallest: (a) electron affinity: Si, P, S, or Cl; (b) effective nuclear charge: Si, P, S, or Cl*

Answers: (a) Si; (b) Si

☐ *Problem Club Question F. Which element has the largest difference between its second and third ionization energies? (a) Rb (b) Sr (c) In (d) Sn (e) Sb*
Answers: (b)

☐ *Problem Club Question G. Which ion has the smallest radius? (a) V^{+5} (b) P^{-3} (c) S^{-2} (d) Sc^{+3} (e) Ti^{+4}*
Answers: (a)

☐ *Problem Club Question H. Comparing Fe^{+2} to Fe^{+3}, which has the largest radius?*
Answers: Fe^{+2}

☐ Read Section 6.3 Ionization Energy.

☐ ☐ Learning Objective 4: Know the trends found in the periodic table with respect to the first ionization energy

☐ ☐ Learning Objective 5: Presented with a group of elements and/or ions, use the periodic table to predict which has the largest/smallest first ionization energy

☐ Do Problem 5 at the end of this section.

☐ Do the following end-of-chapter problems: 40, 42, 48

☐ *Problem Club Question I. Consider two elements aluminum and element X, an element to be identified.*

	Al	X
melting point, ^{o}C	*660*	*1423*
1st ionization, KJ/mol	*577*	*782*

Element X must be (a) barium (b) sodium (c) nitrogen (d) silicon (e) chlorine
Answers: (d)

☐ *Problem Club Question J. Which element of those listed has the largest 1st ionization energy: Ge, As, Se, Sn, Sb, Te*
Answers: As

☐ *Problem Club Question K. Comparing Fe^{+2} to Fe^{+3}, which has the largest ionization energy?*
Answer: Fe^{+3}

☐ Read Section 6.4 Higher Ionization Energies.

☐ ☐ Learning Objective 6: For any given element, predict which ionization will correspond to an unusually large jump in ionization energy.

☐ ☐ Learning Objective 7: What are second, third, etc., ionization energies or electron affinities? Given successive ionization energies (1st, 2nd, 3rd, etc.) for an unknown element, determine the most probable element.

☐ ☐ Learning Objective 8: Presented with a group of elements, use the periodic table to predict which has largest n^{th} ionization energy.

☐ Do Problems 6 - 8 at the end of the section.

☐ Do the following end-of-chapter problems: 44, 46,

☐ *Problem Club Question L. Which element has the largest difference between its second and third ionization energies? (a) Rb (b) Sr (c) In (d) Sn (e) Sb*
Answers: (b)

☐ Read Section 6.5 Electron Affinity.

☐ ☐ Learning Objective 9. Know the trends found in the periodic table with respect to electron affinity.

☐ ☐ Learning Objective 10: Presented with a group of elements and/or ions, use the periodic table to predict which has the largest/smallest electron affinity.

☐ Do Problems 9 and 10 at the end of the section.

☐ Do the following end-of-chapter problems: 50, 52, 54, 56

☐ *Problem Club Question M. Arrange these elements in order of increasing electron affinity: (a) Rb, Sn, I and Xe; (b) Si, Ge, and Sn; (c) Na, Mg, S, or Ar*
Answers: (a) Xe < Rb < Sn < I; (b) Sn < Ge < Si; (c) Ar < Mg (because Mg has a filled subshell, $3s^2$, it has less electron affinity than Na) < Na < S

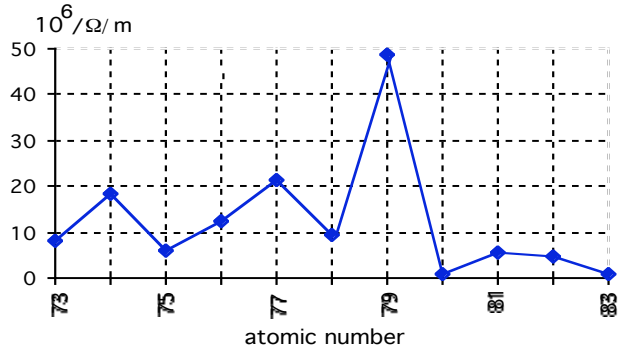
☐ *Problem Club Question N. Which has the smallest electron affinity: Si, P, S, or Cl.*
Answer: P

☐ *Problem Club Question O. Comparing Fe^{+2} to Fe^{+3}, which has the largest electron affinity?*
Answer: Fe^{+3}

☐ ☐ ***Qualitative description of lattice energy, applications of previous chapters Mattson will sum up Section 6.6***

☐ General Understanding

☐ *Problem Club Question P. The electrical conductivity of solid elements with atomic numbers 72 to 83 is given below. If the plot is typical of the variation in electrical conductivity across any related period, which of the these electron configurations would you associate with high electrical conductivity?*



(a) ns^1, alkali metals
(b) ns^2 , alkaline earths
(c) $ns^1(n\text{-}1)d^5$, like chromium
Answer: (d) $ns^1(n\text{-}1)d^{10}$ like copper
(e) ns^2np, like aluminum