8.6 Compare physical and chemical properties of metals and non-metals.

**Metals:** malleable, ductile, generally shiny, electrically and thermally conductive, medium to high melting points, lose electrons in chemical reactions.

**Non-metals:** dull, brittle, electrically and thermally insulating, low melting and boiling points, generally gain electrons in chemical reactions.

8.12 Valence Electrons:

a) **What are valence electrons?** Valence electrons are the electrons involved in chemical bonding, generally the s and p electrons from an element’s highest occupied energy level (Electrons in the outmost energy level).

b) **Fill in this chart for the following elements:**

<table>
<thead>
<tr>
<th>Element</th>
<th>Electron configuration</th>
<th># valence electrons</th>
<th>Group # (if it has one)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al</td>
<td>[Ne] 3s²3p¹</td>
<td>3</td>
<td>III</td>
</tr>
<tr>
<td>Sr</td>
<td>[Kr] 5s²</td>
<td>2</td>
<td>II</td>
</tr>
<tr>
<td>Br</td>
<td>[Ar] 4s²3d¹⁰4p⁶</td>
<td>7</td>
<td>VII</td>
</tr>
<tr>
<td>Mo(#42)</td>
<td>[Kr]5s²4d⁴</td>
<td>2 (or some count 6)</td>
<td>---</td>
</tr>
<tr>
<td>Pb</td>
<td>[Xe]6s²4f¹⁰5d¹⁰6p²</td>
<td>4</td>
<td>IV</td>
</tr>
</tbody>
</table>

8.19 In the periodic table, the element hydrogen is sometimes grouped with the alkali metals and sometimes with the halogens. Explain why hydrogen can resemble the Group I and the Group VII elements.

Hydrogen forms the H⁺ ion (resembles the alkali metals)
Forms the H⁻ ion (resembles the halogens) when combined with metals.

8.27 Write electron configurations for the following ions.

(a) Li⁺: 1s²= [He]  
(f) Se²⁻: [Ar]4s²3d¹⁰4p⁶ = [Kr]  
(k) Ba²⁺: [Xe]

(b) H⁻: 1s² = [He]  
(g) Br⁻: [Ar]4s²3d¹⁰4p⁶ = [Kr]  
(l) Pb⁴⁺: [Xe]⁴f⁹5d¹⁰

(c) N³⁻: 1s²2s²2p⁶ = [Ne]  
(h) Rb⁺: [Kr]  
(m) In³⁺: [Kr]⁴d¹⁰

(d) F⁻: 1s²2s²2p⁶ = [Ne]  
(i) Sr²⁺: [Kr]  
(n) Ag⁺: [Kr]⁴d¹⁰

(e) S²⁻: [Ne]3s²3p⁶ = [Ar]  
(j) Sn²⁺: [Kr]5s²4d¹⁰  
(o) Ru³⁺: [Kr]⁴d⁸

8.31 Which of the following species are isoelectronic with each other? 

C, Cl⁻, Mn²⁺, B⁻, Ar, Zn, Fe³⁺, Ge²⁺

Two species are isoelectronic if they have the same number of electrons.

The following pairs are isoelectronic with each other:

- C and B⁻
- Mn²⁺ and Fe³⁺
- Ar and Cl⁻
- Zn and Ge²⁺
8.34 Describe how the radius changes in each of the following situations and explain why. (You must discuss changes in # main energy levels, # protons and # shielding electrons.)

(a) The atomic radius decreases from left to right across a period because the # protons increases, but the # shielding electrons stays constant--Z_{eff} increases. Thus, the valence electrons get more strongly attracted to the nucleus as go across row, so electrons are pulled in more tightly. *(The # of main energy levels is the same for all going across, so no effect.)*

(b) The atomic radius increases down a group because electrons fill into higher main energy levels, so electrons are further away. # protons do also increase, but # shielding electrons increase by the same amount causing the Z_{eff} to stay constant.

A. Calculate the Z_{eff} for the following two elements: (Show your work.)

1. Ca: 20 protons − 18 shielding electrons = +2 (Ca: [Ar]4s²)
2. I : 53 protons − 46 shielding electrons = +7 (I: [Kr]5s²4d¹⁰5p⁵)

8.37 Select the atom with the larger atomic radius in each of the following pairs:

(a) Na, Cs: Cs is larger (Radius increases down column)
(b) P, Cl: P is larger. (Radius decreases going across row.)
(c) Fr, He: Fr is larger. (Radius increases across to the left and down column.)

8.41 Why is the radius of the lithium atom considerably larger than the radius of the hydrogen atom?

- Li: 1s²2s¹
  - H: 1s¹
- Lithium has a 2s electron which is in a higher main energy level than H’s 1s electron. Electrons in higher main energy levels are further from the nucleus.
- In addition, Lithium’s 2s electron is also shielded from the nucleus by its 1s electrons. This, reduces the attraction of the 2s electrons to the nucleus and allows e^− cloud to expand slightly.

8.43 Indicate which one of the two species in each of the following pairs is smaller and Explain.

(a) Cl or Cl\(^{-}\): **Cl** is smaller than Cl\(^{-}\). Cl has the same number of protons, but has 1 less e\(^-\) so there is less electron-electron repulsion.

(b) Na or Na\(^{+}\): **Na**\(^{+}\) is smaller than Na. Na\(^{+}\) has same # of protons, but one less e\(^-\), with its outermost electrons the core electrons from Na.

(c) O\(^{2-}\) or S\(^{2-}\): **O**\(^{2-}\) is smaller than S\(^{2-}\). Ionic radius increases going down a group because electrons fill into higher energy levels (and Z_{eff} is constant).

(d) Mg\(^{2+}\) or Al\(^{3+}\): **Al**\(^{3+}\) is smaller than Mg\(^{2+}\). The two ions are isoelectronic, but Al\(^{3+}\) has one more proton. Thus, the radius is smaller for Al\(^{3+}\).

(e) Au\(^{+}\) or Au\(^{3+}\): **Au**\(^{3+}\) is smaller than Au\(^{+}\) because they have the same # of protons, but Au\(^{3+}\) has fewer electrons.