CHEM 101 Answer to Homework Problems (4th edition)

Chapter 7

7.19

Elements that have the same number of valence electrons will have similarities in chemical behavior. Looking at the periodic table, elements with the same number of valence electrons are in the same group. Therefore, the pairs that would represent similar chemical properties of their atoms are: (a) and (d), (b) and (e), (c) and (f).

7.35

Strategy: Recall that the general periodic trends in atomic size are:

(1) Moving from left to right across a row (period) of the periodic table, the atomic radius decreases due to an increase in effective nuclear charge.

(2) Moving down a column (group) of the periodic table, the atomic radius increases since the orbital size increases with increasing principal quantum number.

Setup: The atoms that we are considering are all in the same period of the periodic table. Hence, the atom furthest to the left in the row will have the largest atomic radius, and the atom furthest to the right in the row will have the smallest atomic radius. Arranged in order of decreasing atomic radius, we have:

Na > Mg > Al > P > Cl

Solution: See Figure 7.6 of the text to confirm that the above is the correct order of decreasing atomic radius.

7.47
Strategy: Removal of the outermost electron requires less energy if it is shielded by a filled inner shell.

Setup: The lone electron in the 3s orbital will be much easier to remove. This lone electron is shielded from the nuclear charge by the filled inner shell. Therefore, the ionization energy of 496 kJ/mol is paired with the electron configuration 1s\(^2\)2s\(^2\)2p\(^6\)3s\(^1\).

A noble gas electron configuration, such as 1s\(^2\)2s\(^2\)2p\(^6\), is a very stable configuration, making it extremely difficult to remove an electron. The 2p electron is not as effectively shielded by electrons in the same energy level. The high ionization energy of 2080 kJ/mol would be associated with the element having this noble gas electron configuration.

Solution: Compare this answer to the data in Table 7.3 The electron configuration of 1s\(^2\)2s\(^2\)2p\(^6\)3s\(^1\) corresponds to a Na atom, and the electron configuration of 1s\(^2\)2s\(^2\)2p\(^6\) corresponds to a Ne atom.

7.73

We assume the approximate boiling point of argon is the mean of the boiling points of neon and krypton, based on its position in the periodic table being between Ne and Kr in Group 8A.

\[
b.p. = \frac{-246.1^\circ C + (-153.2^\circ C)}{2} = -199.7^\circ C
\]

The actual boiling point of argon is \(-185.7^\circ C\).

7.85

This is an isoelectronic series with ten electrons in each species. The species with the smallest nuclear charge will be the largest. Recall that the largest species will be the easiest to ionize.

increasing ionization energy: \(O^{2-} < F^- < Na^+ < Mg^{2+}\)