CHEM 130
Problem Set Ch. 8

Key begins on page 3.

1. Describe the four quantum numbers used to characterize an electron in an atom.

2. An electron in a certain atom is in the $n = 2$ quantum level. List the possible values of l and m_l that it can have.

3. What is the difference between a $2p_x$ and a $2p_y$ orbital?

4. Write the electron configuration and orbital box diagrams for Al and S.

5. Write the electron configurations for the atoms of chromium and iron.

6. Explain briefly why each of the following is *not* a possible set of quantum numbers for an electron in an oxygen atom (in its ground state). In each case, change the incorrect value (or values) in some way to make the set valid.

   a) $n = 2, \quad l = 2, \quad m_l = 0, \quad m_s = +½$

   b) $n = 2, \quad l = 1, \quad m_l = -1, \quad m_s = 0$

   c) $n = 3, \quad l = 1, \quad m_l = +1, \quad m_s = +½$

7. Draw orbital box diagrams for atoms with the following electron configurations:

   a) $1s^2 2s^2 2p^5$

   b) $1s^2 2s^2 2p^6 3s^2 3p^3$

   c) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^7$

8. How does atomic radius change as we move

   a) from left to right across the period?

   b) from top to bottom in a group?

9. Arrange the following atoms in order of decreasing atomic radius: Na, Al, P, Cl, Mg.

10. Ionization energy usually increases form left to right across the given period. Aluminum, however, has a lower ionization energy than magnesium. Explain.

11. Arrange the following atoms in the order of increasing ionization energy: Si, K, As, and Ca.

12. Compare the elements Li, K, C, and N.

   a) Which has the largest atomic radius?

   b) Which has the most negative electron affinity?

   c) Place the elements in order of increasing ionization energy.

CHEM 1
Problem Set Ch. 8

1. Describe the four quantum numbers used to characterize an electron in an atom.

PRINCIPLE Q.N. $n = 1, 2, 3 \ldots \infty$ MAIN SHELL NUMBER
SUBSIDIARY Q.N. $\ell = 0, 1, 2 \ldots (n-1)$ SUBSHELL NUMBER
MAGNETIC Q.N. $m_\ell = -\ell \ldots +\ell$ ORBITAL NUMBER
SPIN Q.N. $m_s = -1/2$ OR $+1/2$ SPIN NUMBER.

2. An electron in a certain atom is in the $n = 2$ quantum level. List the possible values of l and m_l that it can have.

FOR $n = 2$
POSSIBLE ℓ VALUES = 0 (S ORBITAL) AND 1 (P ORBITAL)
POSSIBLE m_ℓ VALUES = 0 ; $-1, 0, +1$

3. What is the difference between a $2p_x$ and a $2p_y$ orbital?

THEY ARE BOTH DUMBBELL SHAPED ... BUT ARE PERPENDICULAR TO ONE ANOTHER.

4. Write the electron configuration and orbital box diagrams for Al and S.

Al - $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$ (↑↓ ↑↓ ↑↓↑↓↑↓ ↑↓ ↑ | |)

S - $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$ (↑↓ ↑↓ ↑↓↑↓↑↓ ↑↓ ↑↓ ↑ ↑)

5. Write the electron configurations for the atoms of chromium and iron.

$_{24}Cr - 1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^5$ (EXCEPTION)

$_{26}Fe - 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$.

6. Explain briefly why each of the following is *not* a possible set of quantum numbers for an electron in an oxygen atom (in its ground state). In each case, change the incorrect value (or values) in some way to make the set valid.

a) $n = 2,\ l = 2,\ m_l = 0,\ m_s = +½$ — $n = 2$, $\ell = 2$ IMPLIES "2d" SUBLEVEL .... THE SECOND SHELL HAS NO 'd' SUBLEVEL.

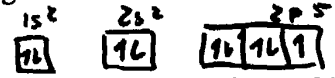
b) $n = 2,\ l = 1,\ m_l = -1,\ m_s = 0$ — $m_s = 0$ IS NOT POSSIBLE ... ONLY VALUES OF $+½$ AND $-½$ ARE ALLOWED.

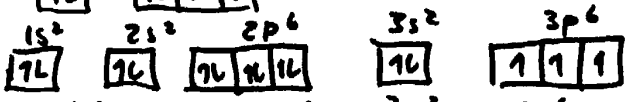
c) $n = 3,\ l = 1,\ m_l = +1,\ m_s = +½$ — $n = 3$ $\ell = 1$ CORRESPONDS TO THE 3p SUBLEVEL. OXYGEN'S GROUND STATE ONLY EXTENDS TO THE 2p SUBLEVEL.

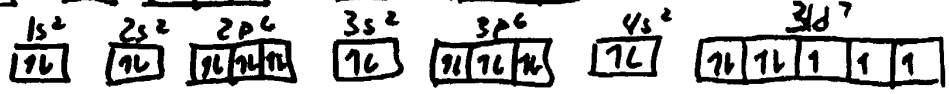
O - $1s^2 2s^2 2p^4$
GROUND STATE

COP C

7. Draw orbital box diagrams for atoms with the following electron configurations:

a) $1s^2 2s^2 2p^5$ 

b) $1s^2 2s^2 2p^6 3s^2 3p^3$ 

c) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^7$ 

8. How does atomic radius change as we move

a) from left to right across the period? SIZE DECREASES L TO R IN A GIVEN PERIOD.

b) from top to bottom in a group? SIZE INCREASES FROM T TO B IN A GIVEN GROUP.

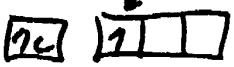
9. Arrange the following atoms in order of decreasing atomic radius: Na, Al, P, Cl, Mg.

$Na > Mg > Al > P > Cl$

10. Ionization energy usually increases form left to right across the given period. Aluminum, however, has a lower ionization energy than magnesium. Explain.

THE 13TH e^- IN Al IS THE FIRST "p" $e^\ominus$ AND IS SLIGHTLY EASIER TO REMOVE THAN IT WOULD BE TO SPLIT THE PAIR OF $e^\ominus$ IN Mg.

Mg - $1s^2 2s^2 2p^6 3s^2$ 

Al - $1s^2 2s^2 2p^6 3s^2 3p^1$  EASIER.

11. Arrange the following atoms in the order of increasing ionization energy: Si, K, As, and Ca.

$K < Ca < As < Si$

12. Compare the elements Li, K, C, and N.

a) Which has the largest atomic radius? K

b) Which has the most negative electron affinity? N

c) Place the elements in order of increasing ionization energy.

$K < Li < C < N$