QUANTUM NUMBERS WORKSHEET KEY

1. Write the 14 sets of quantum numbers that describe the 14 electrons of silicon, Si.

1,0,0,+½ and −½ **2,0,0, +½ and −½**
2,1,1, +½ and −½ **2,1,0, +½ and −½** **2,1,-1, +½ and −½**
3, 0, 0,+½ and −½ **3,1,1,+½** **3,1,0,+½**

2. Indicate the maximum number of electrons in an atom that can have as part of their set of four quantum numbers for each of the following.

a. n = 3 **18**
b. n = 4, l = 2 **10**
c. n = 2, l = 2 **0**
d. n = 4, l = 3, m_l = −1, ms = +½ **1**
e. n = 3, l = 1, m_l = +2 **0**
f. n = 6, l = 3, m_l = −3 **2**

3. Sketch the general shape of the orbitals that are described by the following sets of quantum numbers.

a. 1,0,0 **Sphere See text.**
b. 2,1,1 **Dumbbell See text.**
c. 3,2,2 **Double dumbbell or dumbell and donut See text.**

CHEMISTRY 151 - QUANTUM NUMBERS KEY

1. Write the quantum numbers associated with each of the following.

a. the fifth principle energy level **n = 5**
b. the 6s sublevel **n = 6, l = 0**
c. an orbital on the 3d sublevel **n = 3, l = 2, m_l = +2**
d. the first electron added to the 4f sublevel **n = 4, l = 3, m_l = +3, ms = +½**

2. Indicate the maximum number of electrons in an atom that can have as part of their set of four quantum numbers.

a. n = 8 **128**
b. n = 2, l =1 **6**
c. n = 4, l = 3, m_l = 2 **2**
d. n = 7, l = 1, m_l = 2, m_s = −½ **0**
e. n = 6, l = 0, m_l = 0, m_s = +½ **1**
f. n = 4, l = 2, m_l = −3 **0**
g. n = 8, l = 2 **10**

3. With reference to quantum numbers, explain why the 4f sublevel can hold a maximum of 14 electrons.

The 4f sublevel has the quantum numbers n = 4 and l = 3. When l = 3, ml can only be +3, +2, +1, 0, −1, −2, and −3. Thus there are seven orbitals for the 4f sublevel. Each orbital can have electrons with +½ and −½ for m_s. Thus there are two electrons per orbital. Seven orbitals with two electrons per orbital leads to 14 electrons in the 4f sublevel.

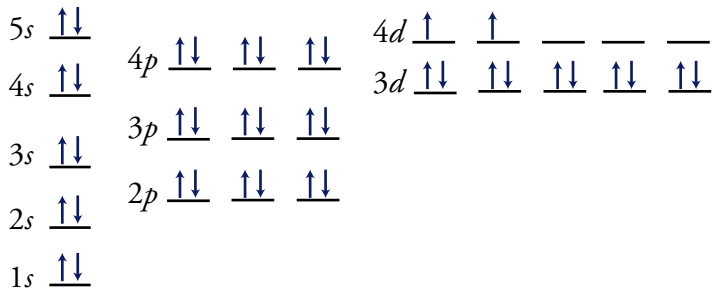
4. Write each of the sets of four quantum numbers that describe the 23 electrons of the ground state of vanadium, V.

1,0,0, +½ and −½ **2,0,0, +½ and −½**
2,1, 1, +½ and −½ **2,1,0, +½ and −½** **2,1,−1, +½ and −½**
3,0,0, +½ and −½ **3,1,1, +½ and −½** **3,1,0, +½ and −½** **3,1,−1, +½ and −½**
4,0,0,+ ½ and −½ **3,2,2, +½** **3,2,1, +½** **3,2,0, +½**

ORBITAL DIAGRAMS AND ELECTRONIC CONFIGURATIONS KEY

1. Write a complete electronic configuration and orbital diagram for zirconium, Zr.

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 5s^2\ 4d^2$



2. Write abbreviated electronic configurations for the following.

a. yttrium, Y **[Kr] $4d^1\ 5s^2$**

b. gold, Au **[Xe] $4f^{14}\ 5d^{10}\ 6s^1$**

c. sulfur ion, S^{2-} **[Ar]**

d. manganese ion, Mn^{2+} **[Ar] $3d^5$**

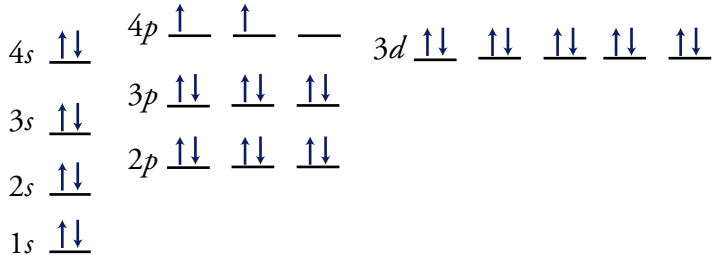
3. Predict whether each of the following is paramagnetic or diamagnetic. For those that are paramagnetic, indicate the number of unpaired electrons that they contain.

	Paramagnetic or Diamagnetic	Number of unpaired e^-
a. mercury, Hg	**Diamagnetic**	----------
b. scandium ion, Sc^{3+}	**Diamagnetic**	----------
c. chromium, Cr	**Paramagnetic**	**6**
d. arsenic, As	**Paramagnetic**	**3**

CHEMISTRY 151 - ORBITAL DIAGRAMS AND ELECTRON CONFIGURATIONS KEY

1. Write a complete orbital diagram and electronic configuration for germanium, Ge.

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^2$



2 & 3. Write abbreviated electronic configurations for the following. Predict whether each atom or ion is paramagnetic or diamagnetic.

a. zinc, Zn **[Ar] $3d^{10}\ 4s^2$** **diamagnetic**

b. thallium ion, Tl^{3+} **[Xe] $4f^{14}\ 5d^{10}$** **diamagnetic**

c. molybdenum, Mo **[Kr] $4d^5\ 5s^1$** **paramagnetic**

d. hafnium, Hf **[Xe] $4f^{14}\ 5d^2\ 6s^2$** **paramagnetic**

ATOMIC SIZE, IONIZATION ENERGY AND ELECTRON AFFINITY KEY

1. Complete the following table by writing the symbol for the element in each pair that has the largest atomic size, highest ionization energy, and most favorable electron affinity. If they are about the same, write "neither".

	Largest atomic size	Highest ionization energy	Most favorable electron affinity
a. P or Bi	**Bi**	**P**	**P**
b. Mg or S	**Mg**	**S**	**S**
c. Cr or Mo	**Mo**	**Cr**	**XXXXXX**
d. V or Ni	**neither**	**neither**	**XXXXXX**

2. Identify each of the following as; (A) always negative (exergonic), (B) always positive (endergonic), or (C) sometimes positive and sometimes negative.

B a. the first ionization energy
B b. the second ionization energy
C c. the first electron affinity
B d. the second electron affinity

3. Write the formulas for three cations and three anions that are isoelectric with argon and arrange them in the order of increasing ionic size.

Sc^{3+} < Ca^{2+} < K^{+} < Ar < Cl^{-} < S^{2-} < P^{3-}

CHEMISTRY 151
ATOMIC SIZE, IONIZATION ENERGY AND ELECTRON AFFINITY KEY

1. Complete the following table.

	Higher ionization energy	Larger size
a. B or F	**F**	**B**
b. Na or Cs	**Na**	**Cs**
c. Ti or Ni	**About the same**	**About the same**
d. Mg^{+} or Mg	**Mg^{+}**	**Mg**
e. Y^{3+} or Y^{2+}	**Y^{3+}**	**Y^{2+}**
f. S^{2-} or Cl^{-}	**Cl^{-}**	**S^{2-}**

2. Circle the formula in each pair that represents the atom with the most favorable electron affinity.

a. **Cl** or I
b. P or **Cl**

CHEMISTRY 151
BOND CHARACTER WORKSHEET KEY

1. For each of the following pairs of ionic bonds, circle the one that has the most covalent character.
   a. Co-O (in CoO) or **Co-S** (in CoS)
   b. **Cr-O** (in Cr_2O_3) or Mo-O (in Mo_2O_3)
   c. K-F (in KF) or **Ca-F** (in CaF_2)
   d. **Co-O** (in CoO) or Co-F (in CoF_2)

2. For each of the following pairs of covalent bonds, circle the one that represents the bond with the most ionic character (the one that is most polar).

   a. $\overset{\delta-}{\textbf{N}}$ **-** $\overset{\delta+}{\textbf{Se}}$ or $\overset{\delta-}{\text{N}}$ - $\overset{\delta+}{\text{Br}}$

   b. $\overset{\delta+}{\textbf{P}}$ **-** $\overset{\delta-}{\textbf{Cl}}$ or $\overset{\delta+}{\text{P}}$ - $\overset{\delta-}{\text{I}}$

3. For each of the covalent bonds in problem 2, indicate which atom has a partial plus charge and which has a partial minus charge.

   See above.