1) Predict which of the following has the largest atomic radius:

    potassium (K) OR selenium (Se) OR rubidium (Rb)

**ANSWER = Rb**  Note that Se is to the right of K in the same period, so K is larger than Se. Rb and K are in the same group and Rb is farther down the group (has more levels), so Rb is larger than K. Therefore, Rb > K > Se

2) Which would you expect to be the larger number, the first ionization energy for calcium OR the second ionization energy for calcium?

**ANSWER = second ionization energy.**  It always requires more energy to remove a second electron from a cation than from the initial atom due to increased net proton pull, among other considerations.

3) Examine each pair given below and determine which is the largest species:

   a) chlorine atom OR chloride ion

   **ANSWER = chloride ion is larger.**  An anion is always larger than its parent atom due to a net minus charge and increased electron repulsions.

   b) cesium atom OR cesium ion

   **ANSWER = cesium atom is larger.**  A cation is always smaller than its parent atom due to a net positive charge and less electron repulsions, and sometimes the loss of the outer level of electrons.
4) Determine which of the species shown below are isoelectronic with neon, then decide which one of those you selected would be have the smallest radius.

oxide ion  argon  magnesium ion  chloride ion  beryllium ion

**ANSWER**= The oxide ion and the magnesium ion both have 10 electrons and so are isoelectronic with element #10 neon. Since the magnesium cation has 12 protons (compared to 8 for oxide), it would pull the 10 electrons in more tightly and be the smaller of these two ions.

5) If a ground state gallium atom (Ga) loses one electron, from which orbital is this electron removed? (HINT: write an electron configuration.)

**ANSWER**= a 4p electron is removed. The electron configuration of Ga is [Ar] $4s^23d^{10}4p^1$. Valence electrons (highest "n" electrons) are lost first, and within a shell, the "p" orbitals are higher energy than "s."

6) A student looked up the electron affinity of phosphorous (-72 kJ/mol) and chlorine (-349 kJ/mol). Which of these two atoms has the greatest affinity for an electron? Use periodic trends to explain our answer.

**ANSWER**= The chlorine has a greater electron affinity. The negative sign simply indicates that energy is released (exotherm) when an electron is gained. The larger the negative #, the greater the EA. We know that Group VIIA elements have higher EA than group VIA and VA elements.

7) What is the difference between an ionic bond and a covalent bond?

**ANSWER**= An ionic bond involves attraction of oppositely charged particles while a covalent bond involves sharing of electrons.
8) Consider the compounds HBr, H₂, Br₂, and KBr. List the type of bonding each would be expected to have. Choose from ionic, nonpolar covalent, and polar covalent.

**ANSWER:**
- HBr (polar covalent) - two different nonmetals
- H₂ and Br₂ (nonpolar covalent) - identical nonmetals
- KBr (ionic) - metal with nonmetal

9) Draw the Lewis structure for the following:

   a) NH₄⁺

   ![Lewis structure of NH₄⁺]

   b) N₂

   ![Lewis structure of N₂]

10) Generate all possible resonance structures for carbon disulfide (CS₂) and use formal charge concepts to assess each structure. Obey the octet rule.

   **ANSWER:** The best structure has a formal charge of zero for each atom - middle structure shown below.

   ![Resonance structures of CS₂]

   Formal charges:
   - S: +1 0 -1
   - C: 0 0 0
   - S: -1 0 +1

11) If you compared a carbon-nitrogen single bond to a carbon-nitrogen triple bond, which would have a higher bond order? Which would have a shorter bond length? Which would require more energy to break?

   **ANSWER:** The answer for all three questions would be the carbon-nitrogen triple bond. It has a bond order of 3, making it shorter and stronger.
12) How many pi bonds are present in a valid Lewis structure of carbon dioxide?

**ANSWER:** There are two pi bonds in carbon dioxide, no matter which valid Lewis structure you use. One structure has two double bonds. Two other versions had both a single bond and triple bond in each structure.

13) Use the proper Molecular Orbital Diagram frameworks provided by your instructor to calculate the bond order and magnetic properties of the following:

a) He$_2$  

b) F$_2$  

c) N$_2^+$

**ANSWER:**

a) BO= 0, diamagnetic  (4 valence e-)

b) BO= 1, diamagnetic  (14 valence e-)

c) BO= 5/2, paramagnetic  (9 valence e-)

Did you use the proper framework in each case? Adjust for charge on question c?

14) For each of the following compounds, determine the molecular geometry, hybridization of the central atom, and whether or not the compound possesses a dipole moment:

a) CHF$_3$  

tetrahedral, sp$^3$, has dipole moment

b) N$_2$  

linear, sp, NO dipole moment

c) TeBr$_6$  

octahedral, d$^2$sp$^3$, NO dipole moment

d) PH$_3$  

trigonal pyramidal, sp$^3$, has dipole moment

e) H$_2$Se  

bent, sp$^3$, has dipole moment

f) BI$_3$  

trigonal planar, sp$^2$, NO dipole moment