INTRODUCTORY CHEMISTRY, CHEM 111 ***
SPRING 2005, TEST 2
Name: _____

Multiple Choice: Read each question carefully. There is only one correct answer to each question. Circle the letter corresponding to the correct answer.
Avogadro's Number = 6.022×10^{23}, c = 2.998×10^{8} m/sec, h = 6.626×10^{-34} Joule sec

1. Which of the following wavelengths of electromagnetic radiation have photons with energy of 5.00×10^{-19} J?
   a) 7.55×10^{14}m b) 3.97×10^{-7}m c) 2.52×10^{6}m d) 7.00×10^{-7}m
   e) none of these

2. Which of the following would be a resonance structure for the compound, X=Z−X. Note that nonbonding electrons are not shown. X and Z are variables representing two different elements.
   a) X=Z=X b) Z=X−Z c) X−Z=X d) Z=X−X
   e) all four are resonance structures

3. Arrange the following elements and ions in order of increasing first ionization energies. K, Ca^{2+}, Ar, Cl^{-}
   a) $K < Ca^{2+} < Ar < Cl^{-}$ b) $K < Cl^{-} < Ar < Ca^{2+}$ c) $Cl^{-} < Ar < Ca^{2+} < K$
   d) $Cl^{-} < Ar < K < Ca^{2+}$ e) none of these

4. Determine the partial charge on the oxygen atom in the polyatomic ion hydroxide, OH^{-}.
   a) −0.61 b) −1.00 c) −0.59 d) −1.22
   d) none of these

5. What is the bond angle in PCl_3?
   a) 90° b) 109° c) 120° d) 180° e) 90° and 120°

6. Which of the ions below would have the electron configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$?
   a) V^{2+} b) Cu^{+} c) Ca^{2+} d) S^{-} e) N^{2-}

7. Determine the total number of bonding electrons and nonbonding electrons (not just around the central atom) in SCl_2.

	Bonding electrons	*Nonbonding electrons*
a)	4	16
b)	6	14
c)	8	12
d)	2	18

   e) none of these

Problems:

1. Draw the Lewis Structure for the following covalent compounds and polyatomic ions.
   a) NO_2^+

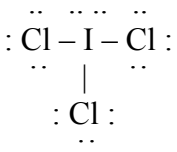
   b) $ClNO_2$

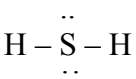
   c) XeF_4

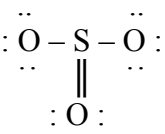
   d) $SiCl_2F_2$

2. Determine the molecular geometry and indicate the polarity (polar or nonpolar) of each of the following.

   Molecular Geometry *Polarity*

   a)
   

   b)
   

   c)
   

3. Give the requested version of the electron configuration for the following atoms or ions.

   a) full electron configuration of phosphorous, P

   b) abbreviated electron configuration with orbital diagrams for the valence electrons of selenium, Se

   c) abbreviated electron configuration of S^{2-}

4. Determine formal charge on each atom for the three structures of thiocyanate given below.

a) [: S≡N−C:]$^-$ b) [:S−C≡N:]$^-$ c) [:C=S=N:]$^-$

Which of the three structures is the best? Justify your answer based on formal charge.

5. For each of the following explain why one substance is polar while the other is not.
   a) CH_2O is polar while CO_3^{2-} is not

   b) H_3O^+ is polar while SiH_4 is not

6. Predict which of each pair will have the largest first ionization energy and explain why based on its electronic structure.

   a) Ca and Sr

   b) Si and Cl

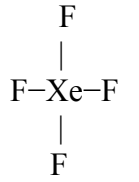
Key:
1. b
2. c
3. b
4. d
5. b
6. d
7. a

Problems
1. a) $[O=N=O]^+$ there are 2 non-bonding electron pairs on each oxygen that are not shown

b) O=N−O
   |
   Cl

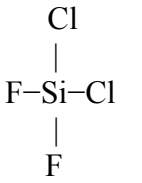
there are 2 non-bonding electron pairs on the left oxygen; there are 3 non-bonding electron pairs on the Cl and the oxygen on the right

c)



there are 3 non-bonding pairs of electrons on each of the fluorines; there are 2 additional non-bonding pairs of electrons on Xe which are not shown

d)



there are 3 non-bonding pairs of electrons on both chlorines and fluorines

2. a) T shaped; polar
   b) Bent; polar
   c) Trigonal planar; non-polar

3. a) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$
   b) $_{18}$[Ar] $4s^2$ $3d^{10}$ $4p^4$
   (↑↓) (↑↓)(↑)(↑)

   c) $_{10}$[Ne] $3s^2\ 3p^6$

4. a) +1, +1, -3 b) -1, 0, 0 c) -2, +2, -1
   Structure (b) is best because the formal charge on each atom has been minimized.

5. a) CH_2O has two types of different atoms (H & O) surrounding the central carbon atom while CO_3^{2-} has three oxygen atoms equally distributed around the central carbon.
   b) The central oxygen has three hydrogens bonded to it and also a non-bonding pair of electrons which have a high electron density. SiH_4 has an equal distribution of hydrogens around the central atom and no non-bonding pairs on the Si.

6. a) Ca because the valence electrons are closer to the nucleus.
   b) Cl because it has more protons in its nucleus than Si.