

CH 222 Problem Set #1

Covering: Chapter Eight, Chapter Nine and Chapter Guide One

Important Tables and/or Constants: Table 8.4 pg. 326 (Bond enthalpies), Figure 8.6 pg. 308 (Electronegativities) and "Geometry and Polarity Guide" (summary of molecular geometries and polarities *Handout*)

1. Give the periodic group number, the number of valence electrons and the number of core electrons for each of the following atoms.
 - a. C
 - b. Cl
 - c. Ne
 - d. Si
 - e. Se
 - f. Al
2. Which of the following elements are capable of forming compounds in which the indicated atom has more than four valence electron pairs?
 - a. C
 - b. P
 - c. O
 - d. F
 - e. Cl
 - f. B
 - g. Se
 - h. Sn
3. Which compound in each of the following pairs should require the higher temperature to melt?
 - a. NaCl or RbCl
 - b. BaO or MgO
 - c. NaCl or MgS
4. Draw a Lewis structure for each of the following molecules or ions.
 - a. CS₂
 - b. BF₄⁻¹
 - c. NO₂⁻¹
 - d. SOCl₂
5. Draw a Lewis structure for each of the following molecules or ions.
 - a. BrF₅
 - b. IF₃
 - c. IBr₂⁻¹
 - d. BrF₂⁺¹
6. Draw a Lewis structure for each of the following molecules or ions. Describe the electron-pair geometry and the molecular geometry around the central atom.
 - a. ClF₂⁺¹ (note: this is one Cl atom, 2 F atoms, and a +1 charge)
 - b. SnCl₃⁻¹
 - c. PO₄³⁻
 - d. CS₂

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7. The following molecules or ions have three oxygen atoms attached to a central atom. Draw a Lewis structure for each one and then describe the electron-pair geometry and the molecular geometry around the central atom. Comment on the similarities and differences in the series.
- CO_3^{2-}
 - NO_3^{-1}
 - SO_3^{2-}
 - ClO_3^{-1}
8. Draw a Lewis structure of each of the following molecules or ions. Describe the electron-pair geometry and the molecular geometry around the central atom.
- SiF_6^{2-}
 - PF_5
 - SF_4
 - XeF_4
9. Give approximate values for the indicated bond angles.
- Cl-S-Cl in SCl_2
 - N-N-O in N_2O
 - Bond angles 1 - 5 in phenylalanine (*right*), one of the natural amino acids and a "breakdown" product of aspartame.
- The diagram shows the Lewis structure of Phenylalanine. It consists of a benzene ring attached to a central carbon atom (C α). This C α is bonded to a hydrogen atom (H) and another carbon atom (C β). The C β is bonded to two hydrogen atoms (H) and a nitrogen atom (N). The nitrogen atom is bonded to two hydrogen atoms (H). The C α is also bonded to a carbonyl group (C=O) and a hydroxyl group (-OH). The oxygen atom in the carbonyl group has two lone pairs, and the oxygen atom in the hydroxyl group has two lone pairs. Five bond angles are indicated with arrows and numbers: 1 is the angle between the phenyl ring and the C α -H bond; 2 is the angle between the C α -H bond and the C α -C β bond; 3 is the angle between the C α -C β bond and the C α -C=O bond; 4 is the angle between the C α -C=O bond and the C α -O-H bond; 5 is the angle between the C β -N bond and the N-H bond.

Phenylalanine
10. Determine the formal charge on each atom in the following molecules or ions:
- SCO
 - HCO_2^{-1} (formate ion)
 - O_3
 - HCO_2H (formic acid)
11. For each of the bonds listed below, tell which atom is the more negatively charged.
- C-N
 - C-H
 - C-Br
 - S-O
12. Considering both formal charge and bond polarities, predict on which atom or atoms the positive charge resides in the following cations:
- H_3O^+
 - NH_4^+
 - NO_2^+
 - NF_4^+
13. Which compound in the list below has the most polar bonds? Which compound(s) in the list are not polar?
- CH_4
 - NH_2Cl
 - BF_3
 - CS_2

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14. Which of the following molecules is (are) not polar? Which molecule has the most polar bonds?
- CO
 - BCl_3
 - CF_4
 - PCl_3
 - GeH_4
15. Give the bond order for each bond in the following molecules or ions:
- CN^{-1}
 - CH_3CN
 - SO_3^{2-}
 - $\text{CH}_3\text{CH}=\text{CH}_2$
16. Phosgene, Cl_2CO , is a highly toxic gas that was used as a weapon in World War I. Using bond energies, estimate the enthalpy change for the reaction of carbon monoxide and chlorine to produce phosgene. (*Hint*: First draw the electron dot structures of the reactants and products so you know the types of bonds involved.) The reaction:
- $$\text{CO(g)} + \text{Cl}_2\text{(g)} \rightarrow \text{Cl}_2\text{CO(g)}$$
17. Which has the greater O-N-O bond angle, NO_2^{-1} or NO_2^{+} ? Explain briefly.