Ch222, S'10, Practice Exam #1

Calculations and Short Answers

1. (10 pts) Use a Born-Haber cycle to calculate the lattice energy of MgCl₂(s). NOTE: in the test I give the data but for this practice exam, I want you to look it up yourself! The reason is there's a tricky step I want you to figure out yourself, and giving you the data gives away the trick!

\[ \Delta H_{\text{rxn}} = -614 \text{ kJ/mol} \]

\[ \Delta H_{\text{sub}} = 146 \text{ kJ/mol} \]

\[ T_1 = 738 \text{ kJ/mol} \]

\[ T_2 = 1447 \text{ kJ/mol} \]

\[ \Delta H = \Delta H_{\text{sub}} \]

\[ \text{BE} = \Delta H_2 \]

\[ \Delta H = -L.E \]

\[ \Delta H_{\text{rxn}} \]

\[ = - L.E \]

\[ = 2256 \text{ kJ/mol} \]

\[ \Delta H_{\text{sub}} = 146 \text{ kJ/mol} \]

\[ = \Delta H_{\text{rxn}} \]

\[ = - L.E \]

\[ = 2256 \text{ kJ/mol} \]

2. (9 pts) Give the BEST Lewis structures for:

(a) COBr₂ (you need to determine the central atom)

\[ 4 + 6 + 2(7) = \frac{24}{2} = 12 \text{ pos} \]

all elements have an octet and a zero formal charge

(b) XeF₆

\[ 8 + 4(7) = \frac{36}{2} = 18 \text{ pos} \]

EC = octahedral

Molecular = square planar

(c) CH₂CHCN (arrangement = C C C N)

\[ 3(4) + 3(1) + 5 = \frac{20}{2} = 10 \text{ pos} \]
3. (6 pts) Give all of the resonance hybrids for CH$_2$NO$_2^-$ (note the negative charge), where the hydrogens are attached to the carbon and the oxygens to the nitrogen.

\[
\begin{align*}
4 + 2(1) + 5 + 2(6) + 1 &= \frac{24}{2} = 12\text{ pts}
\end{align*}
\]

4. Given the bond dissociation energies below, calculate the standard molar enthalpy of formation of ClF$_3$.

Cl$_2$(g) + 3 F$_2$(g) $\rightarrow$ 2 ClF$_3$(g)

<table>
<thead>
<tr>
<th>Bond</th>
<th>Dissociation Energy (kJ/mol)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cl - Cl</td>
<td>243</td>
</tr>
<tr>
<td>F - F</td>
<td>159</td>
</tr>
<tr>
<td>Cl - F</td>
<td>255</td>
</tr>
</tbody>
</table>

\[
\Delta H_{rxn} = \text{break - make}
\]

\[
= \left[ (1) 243 + 3(159) \right] - \left[ 2 \times 3 \times 255 \right]
\]

\[
= 720 - 1530
\]

\[
= -810 \text{ kJ}
\]
Multiple Choice - each question is worth 3 points and there is only one BEST answer.

1. Which element will display an unusually large jump in ionization energy values between I$_3$ and I$_4$, its third and fourth ionization energies?
   (a) Na  (b) Mg  (c) Al  (d) Si  (e) P

2. What are the formal charges on Cl and O respectively for ClO$_5$? 7 + 3(b) + 1 = \frac{2(b)}{2} = \text{charge}
   (a) 0 and 0  (b) +2 and −1  (c) −1 and +2  (d) +1 and −1  (e) −1 and +1

3. Which of the following elements is most likely to form compounds involving an expanded octet?
   (a) Li  (b) N  (c) F  (d) Ne  (e) S

4. The covalent bond with the greatest polarity would form between which of the atom pairs below?
   (a) Br−Br  (b) S−O  (c) C−P  (d) C−O  (e) B−O

5. Which of the elements listed below will have the greatest ionization energy?
   (a) Cs  (b) Ga  (c) K  (d) Bi  (e) As

6. Which of the following elements has the greatest electron affinity (largest positive value = most favorable)?
   (a) K  (b) Br  (c) As  (d) Ar  (e) I

7. Which of those atoms listed below will have the largest radius?
   (a) B  (b) Ga  (c) Br  (d) Si  (e) Cl

8. Which of the elements listed below is the least electronegative?
   (a) Sr  (b) V  (c) N  (d) P  (e) I

9. Which one of the following molecules has an atom with an expanded octet?
   A. HCl  B. AsCl$_5$  C. ICl  D. NCl$_5$  E. Cl$_2$
10. Which one of the following molecules has an atom with an incomplete octet?
   A. NF₃    B. H₂O    C. AsCl₃    D. GeH₄    E. BF₃

11. In which one of the following molecules is the central atom sp² hybridized?
   A. SO₂    B. N₂O    C. BeCl₂    D. NF₃    E. PF₅

12. What is the hybridization on the central atom in NO₃⁻?
   A. sp    B. sp²    C. sp³    D. sp³d    E. sp³d²

13. What is the hybridization of the As atom in the AsF₅ molecule?
   A. sp    B. sp²    C. sp³    D. sp³d    E. sp³d²

14. Indicate the type of hybrid orbitals used by the central atom in SF₆.
   A. sp    B. sp²    C. sp³    D. sp³d    E. sp³d²

15. Predict the molecular geometry and polarity of the SO₂ molecule.
   A. linear, polar    B. linear, nonpolar    C. bent, polar    D. bent, nonpolar    E. None of the above.

16. According to the VSEPR theory, the F–As–F bond angles in the AsF₄⁻ ion are predicted to be
   A. 109.5°    B. 90° and 120°    C. 180°    D. < 109.5°    E. < 90° & < 120°

17. According to the VSEPR theory, the geometry of the atoms in the carbonate ion, CO₃²⁻ is
   A. square planar.
   B. tetrahedral.
   C. pyramidal.
   D. trigonal planar.
   E. octahedral.