Calculations and Short Answers

1. (10 pts) Use a Born-Haber cycle to calculate the lattice energy of MgCl$_2$(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!

2. (9 pts) Give the BEST Lewis structures for:
   
   (a) COBr$_2$ (you need to determine the central atom)

   (b) XeF$_6$

   (c) CH$_2$CHCN (arrangement = C C C N)
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.

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

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

<table>
<thead>
<tr>
<th>Bond</th>
<th>Dissociation Energy (kJ/mol)</th>
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<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>
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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 I₃ and I₄, 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 ClO₃⁻?
   (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) Ni  (d) P  (e) I

9. Which one of the following molecules has an atom with an expanded octet?
   A. HCl   B. AsCl₅   C. ICl   D. NCl₃   E. Cl₂
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
   E. octahedral.