# Session #9: Homework Problems

## Problem #1

Estimate the ionic radius of $Cs^+$. The lattice energy of CsCl is 633 kJ/mol. For CsCl the Madelung constant, *M*, is 1.763, and the Born exponent, *n*, is 10.7. The ionic radius of $Cl^-$ is known to be 1.81 Å.

## Problem #2

(a) CFCs have been implicated in ozone depletion. Show that when Freon 12 ($CCl_2F_2$) is exposed to ultraviolet radiation, the compound decomposes to produce chlorine.
(b) Draw the Lewis structure of Freon 12 and indicate the polarities of each bond within this compound.
(c) Determine the percent ionic character of the C--Cl and C--F bonds.

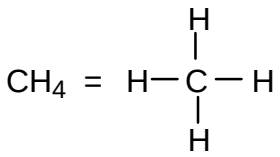
**DATA: Average Bond Energies (kJ/mol)**

| **Single Bonds** | | **Multiple Bonds** | |
|---|---|---|---|
| H-H | 435 | C = C | 610 |
| F-F | 155 | C ≡ C | 836 |
| Cl-Cl | 242 | | |
| C-C | 347 | | |

## Problem #3

The compound trichloroethylene has the composition $C_2Cl_3H$.

(a) Formulate this compound in "Lewis" notation. Example:



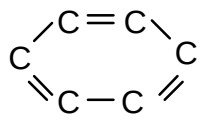
(b) List the types of atomic orbitals which, upon overlap, lead to the formation of the bonds indicated in (a).
(c) List all bonds (number and type) involved in the formation of this compound.

## Problem #4

Frequently the statement is made that the crystal energy ($\Delta E_{cryst}$) is predominantly given by the attractive energy term. How can you account for this approximation?

**Problem #5**

For benzene ($C_6H_6$), which has a schematic *carbon* arrangement?



(a) Determine the total number and types of covalent bonds.
(b) For each bonding type, determine the bonding orbitals which, by overlap, lead to their formation.

**Problem #6**

Why is double bonding encountered in some carbon compounds, but not in germanium compounds – although both exhibit $sp^3$ hybridization?

**Problem #7**

List the individual steps with the corresponding chemical equations used in constructing a Born-Haber cycle for the formation of $CaBr_2$ from the element and identify those which you expect to be exothermic.

**Problem #8**

(a) Given the ionic radii, $Cs^+$ = 1.67Å, $Cl^-$ = 1.81Å, and the Madelung constant *M*(CsCl) = 1.763, determine to the best of your ability the molar Crystal energy ($\Delta E_{cryst}$) for CsCl.
(b) Not given additional data, do you expect the value obtained to be larger or smaller than theoretical, and by how many percent do you anticipate to be off?

3.091SC Introduction to Solid State Chemistry
Fall 2009