

## 9 • Bonding & Molecular Structure

### STUDY QUESTIONS

- Classify the following substances as covalent molecules or ionic compounds:
  - MgO
  - NI<sub>3</sub>
  - CuS
  - NO<sub>2</sub>
  - LiCl
  - SF<sub>4</sub>
  - XeF<sub>4</sub>
  - CsF
- How many valence electrons do the following atoms or ions have? Write their Lewis symbols.
  - Ca
  - S
  - P
  - O<sup>2-</sup>
  - Mg<sup>2+</sup>
  - C<sup>4-</sup>
  - Li
  - Ne
- Which of the following molecules do not obey the octet rule?
  - AlCl<sub>3</sub>
  - PCl<sub>3</sub>
  - PCl<sub>5</sub>
  - SiCl<sub>4</sub>
  - SF<sub>6</sub>
  - BeCl<sub>2</sub>
  - NO<sub>2</sub>
  - XeF<sub>4</sub>
- Order the following salts in increasing lattice energy?  
CaS, MgO, KCl, CsI, NaF
- Draw Lewis electron dot structures for the following molecules.
  - NCl<sub>3</sub>
  - BCl<sub>3</sub>
  - ClO<sub>2</sub><sup>-</sup>
  - SF<sub>4</sub>
  - OCS
  - SO<sub>2</sub>
- Assign formal charges to all the atoms in the following species:
  - chlorite ion ClO<sub>2</sub><sup>-</sup>
  - hydroxylamine HONH<sub>2</sub>
  - phosphorous acid H<sub>3</sub>PO<sub>3</sub>
  - ozone O<sub>3</sub>
  - nitrogen dioxide NO<sub>2</sub>
- Estimate, using the bond energies in Table 9.9 on page 403 of the text, the enthalpy change  $\Delta H^\circ$  for the conversion of propene to isopropanol:  
 $\text{CH}_3\text{-CH=CH}_2 + \text{H}_2\text{O} \rightarrow \text{CH}_3\text{-CH(OH)-CH}_3$
- When ethanol burns in air, heat is released. Estimate the enthalpy of combustion of ethanol vapor  $\Delta H^\circ$  from the average bond energies listed in Table 9.9. Use thermochemical data in Chapter 6 to calculate the same thing. Compare the two values obtained.

9. What is the bond order of the listed bonds in the following molecules or ions?
- |                         |                                    |
|-------------------------|------------------------------------|
| a. C–O in carbonate ion | e. O–O in oxygen in O <sub>2</sub> |
| b. C–O in acetic acid   | f. C–N in hydrogen cyanide         |
| c. N–O in nitrite ion   | g. S–F in sulfur tetrafluoride     |
| d. C–C acetylene        | h. C–O in carbon dioxide           |
10. Draw possible resonance structures for
- NO<sub>2</sub><sup>-</sup>
  - HCO<sub>2</sub><sup>-</sup>
  - NO<sub>2</sub>Cl
11. What molecular shapes are associated with the following electron pairs around the central atom?
- 3 bonding pairs and 2 lone pairs
  - 4 bonding pairs and 1 lone pair
  - 3 bonding pairs and 1 lone pair
  - 2 bonding pairs and 2 lone pairs
  - 2 bonding pairs and 3 lone pairs
  - 5 bonding pairs and 1 lone pair
12. What shapes are the following molecules or polyatomic ions?
- |                                    |                                  |
|------------------------------------|----------------------------------|
| a. O <sub>3</sub>                  | e. NO <sub>2</sub> <sup>+</sup>  |
| b. GaH <sub>3</sub>                | f. ClO <sub>4</sub> <sup>-</sup> |
| c. SO <sub>2</sub> Cl <sub>2</sub> | g. IF <sub>4</sub> <sup>-</sup>  |
| d. XeO <sub>4</sub>                | h. ClF <sub>2</sub> <sup>-</sup> |
13. Determine whether the following molecules are polar or nonpolar:
- |                     |                      |
|---------------------|----------------------|
| a. CCl <sub>4</sub> | e. BF <sub>3</sub>   |
| b. XeF <sub>4</sub> | f. BeCl <sub>2</sub> |
| c. PCl <sub>5</sub> | g. SCl <sub>2</sub>  |
| d. PCl <sub>3</sub> | h. CS <sub>2</sub>   |