1. What two opposing forces dictate the bond length? (Why do bonds form, and what keeps the bonds from getting any shorter?)

2. Why is a Br-Br bond longer than a F-F bond?

3. List the following bonds in order of increasing length: H-Cl, H-Br, H-O.

4. Use the electronegativities to describe the following bonds as purely covalent, mostly covalent, polar covalent, or ionic.

a) C-H **b)** Si-O **c)** Sn-Cl **d)** Rb-Cl

5. Use the electronegativities to describe the following bonds as purely covalent, mostly covalent, polar covalent, or ionic.

a) P-Cl **b)** K-O **c)** N-H **d)** In-Br

6. Name the following compounds:

a) XeF_6 **b)** N_2O_3 **c)** BCl_3 **d)** NH_3

7. Name the following compounds:

a) S_2Cl_2 **b)** CCl_4 **c)** PCl_5 **d)** HCl

8. Name the following compounds:

a) Hg_2Cl_2 **b)** CS_2 **c)** NO **d)** CsCl

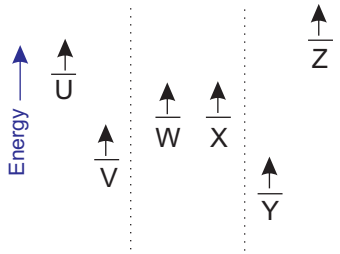
9. Write formulas for each of the following compounds:

a) dinitrogen tetroxide **b)** nitrogen monoxide **c)** dinitrogen pentoxide

10. Write formulas for each of the following compounds:

a) oxygen difluoride **b)** phosphorus trichloride **c)** chlorine trifluoride

11. Use the orbital diagrams for the orbitals involved in the U-V, W-X, and Y-Z bond shown below to determine if the bond is polar. If so, indicate the direction of the bond dipole with an arrow. Rank the bonds in order of increasing polarity.



12. Use an arrow to indicate the bond dipole direction in each of the following bonds:

a) C-F **b)** C-Si **c)** Cl-F **d)** Cl-I

13. Use an arrow to indicate the bond dipole direction in each of the following bonds:

a) S-O **b)** C-H **c)** O-H **d)** C-O

14. Use only the position of the atoms on the periodic table to list the following bonds in order of decreasing polarity:

a) O-F, C-F, Ga-F **b)** H-O, H-S, H-Cl **c)** S-O, Cl-O, P-O

15. Use only the position of the atoms on the periodic table to list the following bonds in order of decreasing polarity:

a) S-O, Se-O, As-O **b)** F-F, H-F, N-F **c)** P-Cl, Sb-Cl, Sn-Cl

16. For each of the species listed below, indicate the number of electrons required to give each atom an octet or duet (ER), the number of valence electrons (VE), and the number of shared pairs (SP) in the Lewis structure.

a) C_6H_6 **b)** C_3O_2 **c)** NH_2^{1-} **d)** PH_4^{1+}

17. For each of the species listed below, indicate the number of electrons required to give each atom an octet or duet (ER), the number of valence electrons (VE), and the number of shared pairs (SP) in the Lewis structure.

a) N_2O_4 **b)** CH_4O **c)** $HBrO_2$ **d)** $S_2O_8^{2-}$

18. Draw Lewis structures for each of the following molecules, and indicate all nonzero formal charges. Note that O_3 is not triangular, and the skeleton of S_2N_2 is N-S-S-N.

a) PF_3 **b)** O_3 **c)** S_2N_2 **d)** N_2H_2

19. Organic compounds are those based on carbon. Because of the way carbon atoms can bond to one another, there are literally an infinite number of organic compounds. Drawing Lewis structures of organic compounds is very important, and the procedure is simplified because there are always four bonds drawn to a carbon atom (a double bond counts as two bonds and triple bond as three). Draw Lewis structures for each of the following organic compounds and indicate all nonzero formal charges.

a) C_2H_2 **b)** C_3H_4 **c)** C_3H_6 **d)** COF_2

20. Draw Lewis structures for each of the following ions and indicate all nonzero formal charges.

a) CO_3^{2-} **b)** NH_4^{1+} **c)** CHO_2^{1-} **d)** ClO_2^{1-}

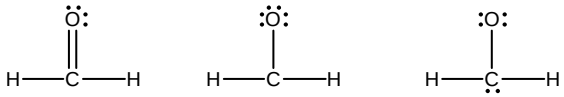
21. Draw Lewis structures for each of the following ions and indicate all nonzero formal charges.

a) NO_3^{1-} **b)** NO^{1+} **c)** N_3^{1-} **d)** NO_2^{1-}

22. For which molecules in Exercises 18 and 19 are more than one resonance form important?

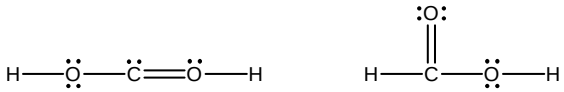
23. For which ions in Exercises 20 and 21 are more than one resonance form important?

24. Indicate all nonzero formal charge on the resonance structures of formaldehyde shown below and rank the structures in order of importance in describing the bonding. Explain your reasoning.



A **B** **C**

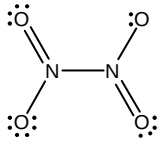
25. Which of the Lewis structures of formic acid shown below is preferred? Justify your answer.



A **B**

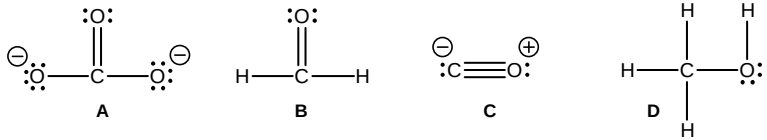
26. The hypochlorite ion, ClO^{1-}, is the active ingredient in bleach. Draw its Lewis structure and determine the formal charges and oxidation states of both atoms. Hypochlorous acid is made by adding H^{1+} to the hypochlorite ion. Based on the formal charges, does hypochlorous acid have an H-Cl bond or an H-O bond?

27. What are the formal charges and oxidation states of the nitrogen atoms in N_2O_4?



28. Draw three resonance structures for the hyponitrite ion, $N_2O_2^{2-}$ (one N-N bond and two N-O bonds) and show all nonzero formal charges. Which structure is the preferred structure? Justify your answer.

29. List the following in order of increasing cabon-oxygen bond lengths and bond energies:

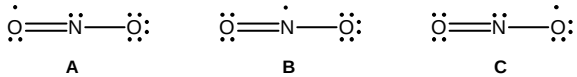


A **B** **C** **D**

30. List the following in order of increasing nitrogen-oxygen bond lengths and bond energies: NO_3^{1-}, NO^{1+}, NOCl, NO_2^{1-}

31. List the following in order of increasing nitrogen-nitrogen bond lengths and bond energies: N_2H_2, N_2, N_2H_4.

32. NO_2 has an odd number of electrons. Using only formal charge, rate the three possible resonance structures below (1 = best, 3 = worst).



A **B** **C**

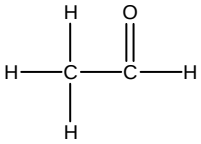
The lone electron on two NO_2 molecules combines to form N_2O_4 with the Lewis structure shown in Exercise 27. Based on this fact where is the lone electron on NO_2? The difference is due to the fact that the oxygen atom is so electronegative that it takes the electrons it needs to fill its valence shell.

33. Draw two structures for BF_3, one that obeys the octet rule and one in which boron is electron deficient. Based on formal charge considerations, which structure is preferred?

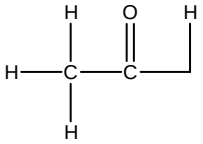
34. Exercises 32 and 33 are examples of exceptions to the octet rule. What atom is the most common exception to the octet rule?

35. Draw Lewis structures that show all nonzero formal charge for the three resonance forms of the cyanate ion (NCO^{1-}) and the fulminate ion (CNO^{1-}). In each case, determine the resonance structure that is most important in describing the bonding in the ion. The cyanate ion is a stable ion, but the fulminate ion is used in explosives. Suggest a reason for this dramatic difference in stability.

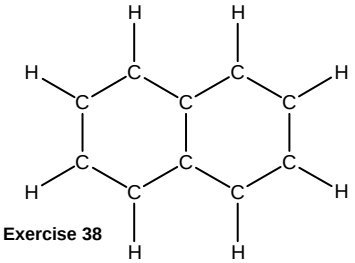
Use the following Lewis structures for Exercises 36-38.



Exercise 36



Exercise 37



Exercise 38

36. In compounds with more than one atom of the same type, the oxidation state of those atoms derived from the procedure presented in Section 4.4 leads to the average oxidation state of the atom, not the oxidation states of the individual atoms. For example, consider the molecule C_2H_4O.

a) Use the method of Section 4.4 to determine the oxidation state of the carbon.

b) Use the Lewis structure of the compound shown in the margin and the method presented in Section 5.8 to determine the oxidation state of each carbon atom in C_2H_4O. Does either carbon have the oxidation state derived in part a?

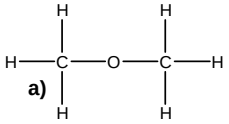
37. Apply the discussion given in Exercise 36 to acetic acid, $HC_2H_3O_2$ (See above for the Lewis structure.)

a) Use the method of Section 4.4 to determine the oxidation state of the carbon.

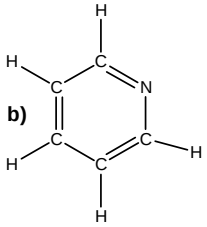
b) Use the Lewis structure of acetic acid shown to the right and the method presented in Section 5.8 to determine the oxidation state of each carbon atom in $HC_2H_3O_2$. Does either carbon have the oxidation state derived in part a?

38. Add double bonds to the Lewis structure of naphthalene ($C_{10}H_8$, see top of page for the Lewis structure), the active ingredient in mothballs, so that each carbon atom has an octet. How many resonance structures can be drawn for naphthalene? Estimate the lengths of the carbon-carbon bonds. Hint: refer to Table 5.3 and the discussion in Section 5.7.

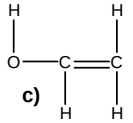
39. Lone pairs are often left out of molecular drawings, but, as we shall see in Chapter 6, they are important in determining the shape of the molecule. Indicate any missing lone pairs in the following. (Assume that all atoms except H obey the octet rule.)



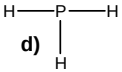
a)



b)



c)



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