

Chapter 1 – Atomic and Molecular Structure**Think About It:**

What is organic chemistry?

Describe some of the ways that ancient civilizations have taken advantage of organic reactions and properties of organic compounds.

What is it about carbon that makes it idea as a chief constituent of organic molecules?

Why would the type of molecular diversity that carbon affords, not be possible with oxygen or silicon?

List the three types of subatomic particles and describe their charge characteristics.

- 1.
- 2.
- 3.

How is the size of an atom defined?

Problem 1.1 (p. 6)

How many protons and electrons does a cation of the carbon atom have if its net charge is +1?

Problem 1.2

(a) How many protons and electrons does an anion of the carbon atom have if its net charge is -1?

(b) How many protons and electrons does a cation of the oxygen atom have if its net charge is +1?

(c) How many protons and electrons does an anion of the oxygen atom have if its net charge is -1?

Think About It:

What does the *principal quantum number* (n), define?

How many orbitals are in the first shell ($n=1$)? What are those orbitals? How many electrons total, can fit in the first energy shell?

Define, *ground state configuration*.

Describe these rules:

(a) Pauli's exclusion principle –

(b) Aufbau principle –

(c) Hund's rule –

YOUR TURN 1.1

In Figure 1-7, place a box around all of the orbitals in the second shell and label them. Draw the result in space below.

Think About It:

How are valence electrons different from core electrons?

YOUR TURN 1.2

In Figure 1-8, place a circle around the valence electrons and label them. Place a box around all the core electrons and label them.

Problem 1.3

Write the ground state electron configuration of the nitrogen atom. How many valence electrons does it have? How many core electrons does it have?

Problem 1.4

Write the ground state electron configuration of the oxygen atom. How many valence electrons are there? How many core electrons are there?

YOUR TURN 1.3

Estimate the bond energy of the bond represented by Figure 1-10a.

Problem 1.5

In the diagram on page 9, which curve represents a stronger covalent bond? The red one or blue? Explain.

Problem 1.6

On the graph on page 10, which of the two curves represents a longer bond? Explain.

YOUR TURN 1.4

Refer to Tables 1-2 and 1-3 to answer the following questions, which are designed to acquaint you with the range of strengths of common bonds.

- (a) What is the value of the strongest single bond listed?
- (b) What does that bond correspond to?
- (c) What is the value of the weakest single bond?
- (d) What bond does that correspond to?
- (e) What is the value of the strongest bond of any type?
- (f) What bond does that correspond to?

YOUR TURN 1.5

Write out the Lewis structure as shown, and circle the electrons that compose carbon's octet, oxygen's octet, and each hydrogen's duet.

Problem 1.7

Following the steps for drawing Lewis Structures, Draw a Lewis structure of HCO_2^- , where carbon is the central atom.

Problem 1.8

Draw a Lewis structure for $\text{C}_2\text{H}_3\text{N}$. A carbon that is bonded to three hydrogen atoms is bonded to the second carbon, which is bonded, in turn, to the nitrogen.

Problem 1.9

For each structure in the problem, determine whether it is a legitimate Lewis structure. If not, explain why not. Write the legitimate Lewis structures below.

Problem 1.10

Complete the Lewis structure for the compound whose skeleton is shown as indicated in the text. Assume that all atoms are uncharged. Write the completed structure below.

Problem 1.11

Complete the Lewis structure for the indicated molecule in the text. You may assume that all atoms have the number of bonds and lone pairs as listed in Table 1-4.

YOUR TURN 1.6

Draw the Lewis structure of BH_3 as shown in the text. Write the electronegativity next to each atom, using Figure 1-16. Along one of the B—H bonds, draw the corresponding dipole arrow, and add the δ^+ and δ^- symbols.

Problem 1.12

Draw below each uncharged molecule as shown in the text. For each,
(a) complete the Lewis structure by adding multiple bonds and lone pairs, and
(b) draw dipole arrows along each **polar covalent bond**. Pay attention to the lengths of the arrows.

(i)

(ii)

(iii)

Problem 1.13

Which of the compounds in the problem is consistent with the electrostatic potential map shown? Explain.

YOUR TURN 1.7

Calculate the difference in electronegativity between the elements in NaCl (an ionic compound) and those in CH_4 (a covalent compound). What do you notice?

NaCl _____ CH_4 _____

Problem 1.14

Identify each of the following as either an ionic compound (i.e., one containing ionic bonds) or a covalent compound (i.e., once containing only covalent bonds).

(a) NH_4CHO_2

(b) LiOH_2CH_3

(c) $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$

Problem 1.15

Which of the following in the text are ionic compounds (i.e., ones containing only covalent bonds)?

YOUR TURN 1.8

Fill in the table below for a carbon atom.

Number of valence electrons	Total number of electrons	Number of protons	Charge
3			
4			
5			

Think About It:

Describe the two methods whereby charges are assigned to atoms that are covalently bonded?

1.

2.

Problem 1.16

For the methanoate anion (formate anion, HCO_2^-) shown, draw the structure, then determine the formal charge and the oxidation state of every atom.

YOUR TURN 1.9

Sum the formal charges and oxidation states assigned in Problem 1.16. What do you notice?

Formal charges _____ Oxidation states _____

Problem 1.17

Determine the formal charge and oxidation state of each atom in the molecule in the text. (Note: You may assume each atom has a filled valence shell.)

Problem 1.18

Which of the following resonance structures makes a greater contribution to the resonance hybrid?

Problem 1.19

Which of the following resonance structures makes a greater contribution to the resonance hybrid? Note: Formal charges are not shown.

Think About It:

Write out the key points (Rules) for resonance theory.

Rule 1

Rule 2

Rule 3

Rule 4

Rule 5

Rule 6

YOUR TURN 1.10

Draw out the structures as shown, then supply the necessary curved arrows to go from the resonance structure on the left to the resonance structure on the right.

Problem 1.20

Draw the species as shown, then draw all resonance structures for it.

Problem 1.21

Draw the compound as shown in the text that belongs to a class of compounds call enamines.
Draw all resonance structures, including minor contributors.

YOUR TURN 1.11

Draw in the curved arrows needed to convert the third resonance structure in Figure 1-27 to the fourth.

YOUR TURN 1.12

The resonance structures of the propargyl cation are shown in the text. Draw the structures as shown, then the curved arrows necessary to convert the first resonance structure into the second.

Problem 1.22

Draw all resonance structures of the species as shown in the text.

YOUR TURN 1.13

Draw the fourth and fifth resonance structures in problem indicated in text, then draw the necessary curved arrows to transform the fourth resonance structure into the fifth.

Problem 1.23

Draw the resonance hybrid of the species indicated (if necessary, consult the individual resonance structures shown just before Your Turn 1.13).

Problem 1.24

Draw all resonance structures of the species indicated. Remember to keep formal charges to a minimum when possible. Which do you think makes the greatest contribution to the resonance hybrid?

Problem 1.25

Draw all resonance structures of the following compound, making certain to keep formal charges to a minimum. Be sure to include curved arrows to indicate which pairs of electrons are being shifted around.

Problem 1.26

Draw all resonance structures of each of the following species indicated. Be sure to include curved arrows to indicate which pairs of electrons are being shifted.

(a)

(b)

(c)

(d)

Problem 1.27

Draw the complete Lewis structure of each of the indicated species, including lone pairs.

(a)

(b)

(c)

(d)

(e)

Problem 1.28

Draw the Lewis structure for $\text{CH}_3\text{CHCHCHO}$

Problem 1.29

Redraw each of the following Lewis structures as the corresponding line structure.

(a)

(b)

(c)

Problem 1.30

For each of the following line structures indicated, draw in all carbon atoms, hydrogen atoms, and lone pairs.

(a)

(b)

(c)

Problem 1.31

Why is it incorrect to draw resonance structures for propene as shown?

Problem 1.32

Draw all resonance structures for each of the following ions using only line structures.