

# Constructing Molecular Models

## PROBLEM

How are molecular model kits used to study molecules?

## INTRODUCTION

Molecules are three dimensional structures. Molecular models can be used to study their shape. In this laboratory exercise, you will use a molecular model kit to construct models of molecules and you will draw diagrams illustrating their structures.

## MATERIALS (per group)

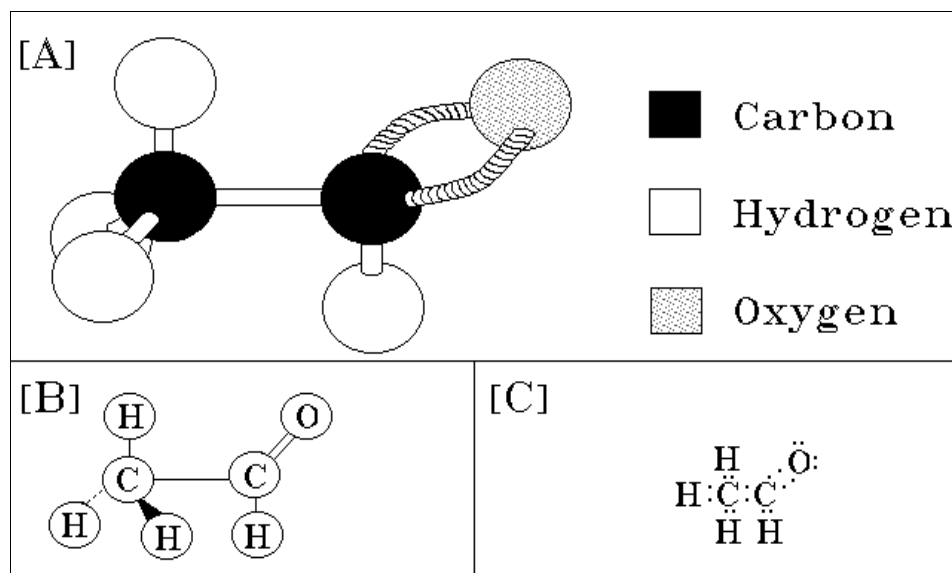
Molecular model kit

## PROCEDURE

1. Examine the contents of the molecular model kit. Each kit should contain colored spheres to represent atoms and sticks or springs to represent bonds. Table I shows the characteristics of each of the types of spheres.
2. To begin constructing a model, select the spheres needed to represent each of the atoms shown by the formula. For example, if the formula were  $C_2H_4O$ , you would select two black spheres, four yellow spheres, and one red sphere.
3. After selecting the spheres, attach them together using the sticks. Each stick represents a single bond. Use long sticks to represent bonds between two carbons, and short sticks to represent other bonds. See Figure 1-a below.
4. The holes in the spheres represent bonding sites. Attach the spheres together in such a way that all the holes are filled. If all the holes are not filled when all the spheres are in place, use springs to make double or triple bonds. See Figure 1-a below.

Table I. Characteristics of spheres representing atoms

Element	Color	Holes
Carbon	Black	4
Hydrogen	Yellow	1
Oxygen	Red	2
Nitrogen	Blue	5
Chlorine	Green	1
Bromine	Orange	1
Iodine	Purple	1



**Figure 1.** The structure of  $C_2H_4O$ : (a) a molecular model; (b) a molecular diagram; (c) an electron dot diagram.

5. Construct models of each of the following: (1) hydrogen [ $\text{H}_2$ ]; (2) chlorine [ $\text{Cl}_2$ ]; (3) hydrogen chloride [ $\text{HCl}$ ]; (4) water [ $\text{H}_2\text{O}$ ]; (5) oxygen [ $\text{O}_2$ ]; (6) nitrogen [ $\text{N}_2$ ]; (7) ammonia [ $\text{NH}_3$ ]; and (8) methane [ $\text{CH}_4$ ]; (9) ethene [ $\text{C}_2\text{H}_4$ ]; (10) chloroethane [ $\text{C}_2\text{H}_5\text{Cl}$ ].
6. Based on the model, draw a molecular diagram of each compound on a separate sheet of paper. Draw a circle for each atom labeled with its symbol and a line for each bond. For bonds going behind the plane of the paper draw a dotted line. For bonds in the plane of the paper draw a single line. For bonds coming out of the plane of the paper, draw a heavy line in perspective. See Figure 1-b on the previous page.
7. On a separate sheet of paper, draw the electron dot diagram for each compound. See Figure 1-c on the previous page. Each bond represents a shared pair of electrons. Outer shells should be complete.

#### ~~OBSERVATIONS~~

**DRAWINGS:** (On separate sheet)

1. Which of the compounds above has double bonds? \_\_\_\_\_
2. Which of the compounds above has triple bonds? \_\_\_\_\_
3. For which of the compounds above is it impossible to fill all the bonding sites? \_\_\_\_\_  
\_\_\_\_\_
4. How many other atoms can carbon combine with at once (*HINT*: Look at methane.)? \_\_\_\_\_  
\_\_\_\_\_

#### ~~CONCLUSIONS~~

1. Why does the black sphere have four holes (*HINT*: Refer to the periodic table.)? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
2. Why does the blue sphere have extra holes that are sometimes not used? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
3. What is the purpose of using molecular models? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

# Molecular Model Drawings

(1) hydrogen [ $\text{H}_2$ ]	(2) chlorine [ $\text{Cl}_2$ ]
(3) hydrogen chloride [ $\text{HCl}$ ]	(4) water [ $\text{H}_2\text{O}$ ]
(5) oxygen [ $\text{O}_2$ ]	(6) nitrogen [ $\text{N}_2$ ]
(7) ammonia [ $\text{NH}_3$ ]	(8) methane [ $\text{CH}_4$ ]
(9) ethene [ $\text{C}_2\text{H}_4$ ]	(10) chloroethane [ $\text{C}_2\text{H}_5\text{Cl}$ ]