Chapter 6: Quick Activities

How Atoms Bond

Gumdrop Molecules

Create molecular models using tooth- picks and colored gumdrops. We recommend black or purple for carbon, white or yellow for hydrogen, green for chlorine, and red for oxygen.

PROCEDURE

1. To build plausible molecular structures, you need to follow these two rules:

   a. Each atom has a specific number of bonds it is able to form, as follows: carbon (4), hydrogen (1), chlorine (1), oxygen (2).

   b. When atoms are placed together within a single molecule, the atoms need to be as far apart from each other as possible while still also connected

2. Using the preceding information, build plausible structures for the following compounds: methane, CH_4; dichloromethane, CH_2Cl_2; ethane, C_2H_6; hydrogen peroxide, H_2O_2; acetylene, C_2H_2. Build these structures before looking at their photos below.

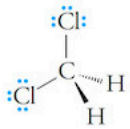
ANALYZE AND CONCLUDE

1. For methane, is it possible to have all five atoms connected lying flat on the table? What is the angle between your hydrogen- carbon-hydrogen bonds? Is it possible to make all these angles greater than 90°? For hydrogen peroxide, would it be preferable to have the two hydrogens on the same side or opposite sides of the oxygen atoms?

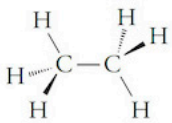
2. Using the above rules, how many structures are possible for C_2H_6O?

3. Why do the atoms of molecules tend to be as far apart from each other as possible? Can all molecular structures be deduced from only the chemical formula for that molecule?

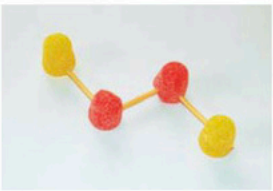
4. Looking for more challenges? Try building the structures for carbon dioxide, CO_2; water, H_2O; and ammonia, NH_3. All of these structures were given to you in this chapter. For an ultimate challenge, try benzene, C_6H_6 , or acetic acid, $C_2H_4O_2$.

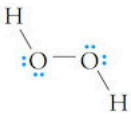


Dichloromethane, CH_2Cl_2, tetrahedron

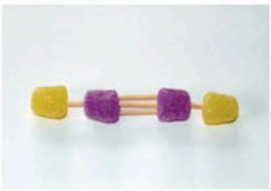


Ethane, C_2H_6, two tetrahedrons





Hydrogen peroxide, H_2O_2, two bent shapes stuck together



Acetylene, C_2H_2, linear

Crystals

View crystals of table salt up close with a smart phone, a magnifying glass, or, better yet, a microscope if one is available. Crush some crystals with a spoon and examine the resulting powder. Purchase sodium-free salt, which is potassium chloride, KCl, and examine these ionic crystals both intact and crushed. Sodium chloride and potassium chloride both form cubic crystals, but there are significant differences. What are they?

Author Responses to Quick Activities

Gumdrop Molecules

1. Yes, it is possible to have all five atoms laying flat on the table. In this arrangement, the atoms are 90 degrees apart. Move the atoms into three dimensions and you can get a structure in which the atoms are all 109 degrees apart. For hydrogen peroxide, it is preferable to have the hydrogen on opposite sides of the oxygen atoms.

2. Two structures are possible: one where the two carbon atoms are connect to each other and another where there is an oxygen atom situated between the two carbon atoms.

3. The atoms of a molecule prefer to be as far apart from each other because of the electric repulsions between them. The chemical formula tells us how many of which kinds of atoms there are in a molecule. It does not, however, tells us how those atoms are placed together. Consider C_4H_{10}. As is discussed in Chapter 12, there are two distinct molecules that can be made with four carbon and ten hydrogen atoms. For small molecules, such as CH_4, the chemical structure can be deduced. For larger molecules, however, more information is needed.

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4. The structure for benzene can be found in Section 12.2. That of acetic acid can be found in Section 10.2.

Crystals

The potassium chloride crystals are more rounded at the edges because it is a softer crystal. One of the reasons it is a softer crystal is because the ionic bond between potassium and chlorine ions is weaker than the ionic bond between sodium and chlorine ions. The reason it is weaker is because the potassium ions are larger than the sodium ions, which means that potassium ions are not able to get as close to the oppositely charged chloride ions. When it comes to the electrical attractions, the farther away, the weaker the force.