Reading for Activity 3.1
Molecules and Their Representations

In the previous unit, you learned that the particles that make up substances are atoms or groups of atoms held tightly together called *molecules*. Now you will learn more how molecules can be represented in images and diagrams.

Because atoms and molecules are too small to be seen, models are used to represent them. Most models use spheres to represent atoms. Molecular models communicate certain information through visual representation. In particular, molecular models convey the type and number of atoms in a molecule. Different types of atoms in a molecule are usually represented by different colors to distinguish them from each other. However, real atoms do not actually have any color.

Molecules can consist of one type of atom or multiple types of atoms . For example, all oxygen molecules in Figure 1a have two atoms of oxygen, and all carbon monoxide molecules have one oxygen atom and one carbon atom. Molecules of a particular substance always have the same composition and ratio of atoms, so oxygen molecules always have two oxygen atoms and carbon monoxide molecules always have one oxygen atom and one carbon atom.

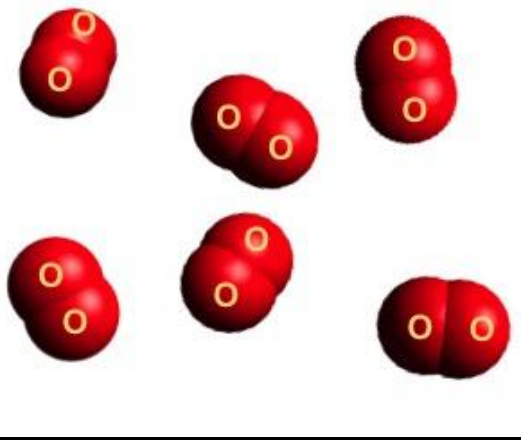

Figure 1a: Molecules of oxygen consist of two of the same type of atoms.

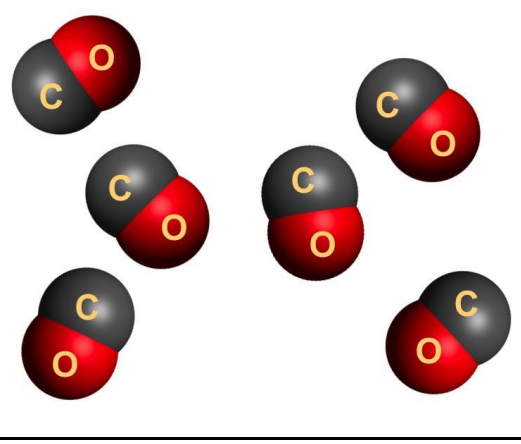

Figure 1b: Molecules of carbon monoxide. Each molecule consists of atoms of two elements, carbon and oxygen.

Different numbers of the same types of atoms in a molecule make different substances. For instance, ozone consists of three oxygen atoms (see Figure 2), while a molecule of oxygen gas consists of two oxygen atoms (see Figure 1a). Although both of these substances are made from oxygen atoms, they have different properties. Oxygen is a colorless, odorless gas that is crucial for supporting life, while ozone is a

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pale blue gas and has a distinctive, strong odor that is harmful to breathe in high concentrations.

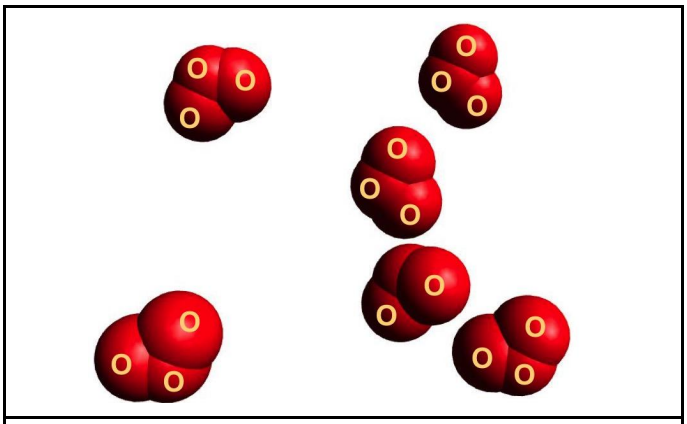
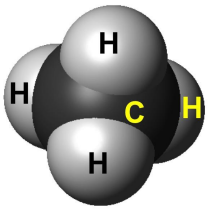
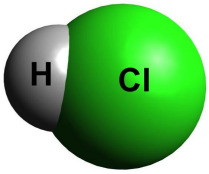
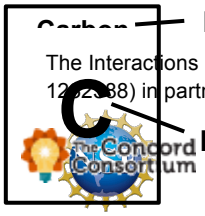


Figure 2: Molecules of ozone

Different types of atoms in a molecular model can be shown to have different sizes to reflect knowledge about relative sizes of atoms. For example, hydrogen atoms are smaller than atoms of any other element. In the table below, hydrogen atoms are represented as white spheres. The molecular models containing hydrogen show it to be much smaller than the chlorine atom in hydrochloric acid and the nitrogen atom in ammonia. In summary, the color and size of the spheres that represent atoms in the molecular model convey specific information about the atoms that make up the molecules of that particular substance.

Substance	Molecular Model
Methane	
Hydrochloric acid	

Chemical Formulas

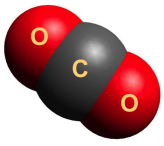
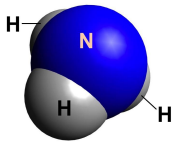
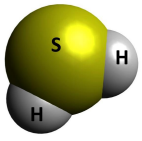


There are other ways to represent molecules. In the previous unit, you learned that elements can be represented by symbols that are summarized in the periodic table. For example, C is the symbol that represents carbon.

Molecules can be represented by a *chemical formula* (sometimes called a *molecular formula*). A chemical formula indicates

- the types of atoms, or elements, in the molecule
- the number of each type of atom in the molecule

In a chemical formula, the subscript number after the element symbol indicates the number of atoms of that element contained in each molecule of the substance. If there is no subscript number after an element symbol, that means there is just one atom of that element contained in each molecule. For instance, the molecular formula for water is H_2O. This indicates that there are two hydrogen atoms and one oxygen atom in each molecule of water. There are some examples of molecules and their chemical formulas in the table below.

Substance	Chemical Formula	Molecular Model
Nitrogen	N_2	
Carbon dioxide	CO_2	
Ammonia	NH_3	
Hydrogen sulfide	H_2S	

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Fill in the blanks in the table below.

	Name	Chemical formula	Number and type of atoms
1	Nitrogen	N_2	
2	Helium		1 helium atom
3	Ammonia		1 nitrogen atom and 3 hydrogen atoms
4	Carbon dioxide	CO_2	
5	Hydrogen	H_2	
6	Methane		4 hydrogen atoms and 1 carbon atom
7	Neon	Ne	
8	Chlorine		2 chlorine atoms

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