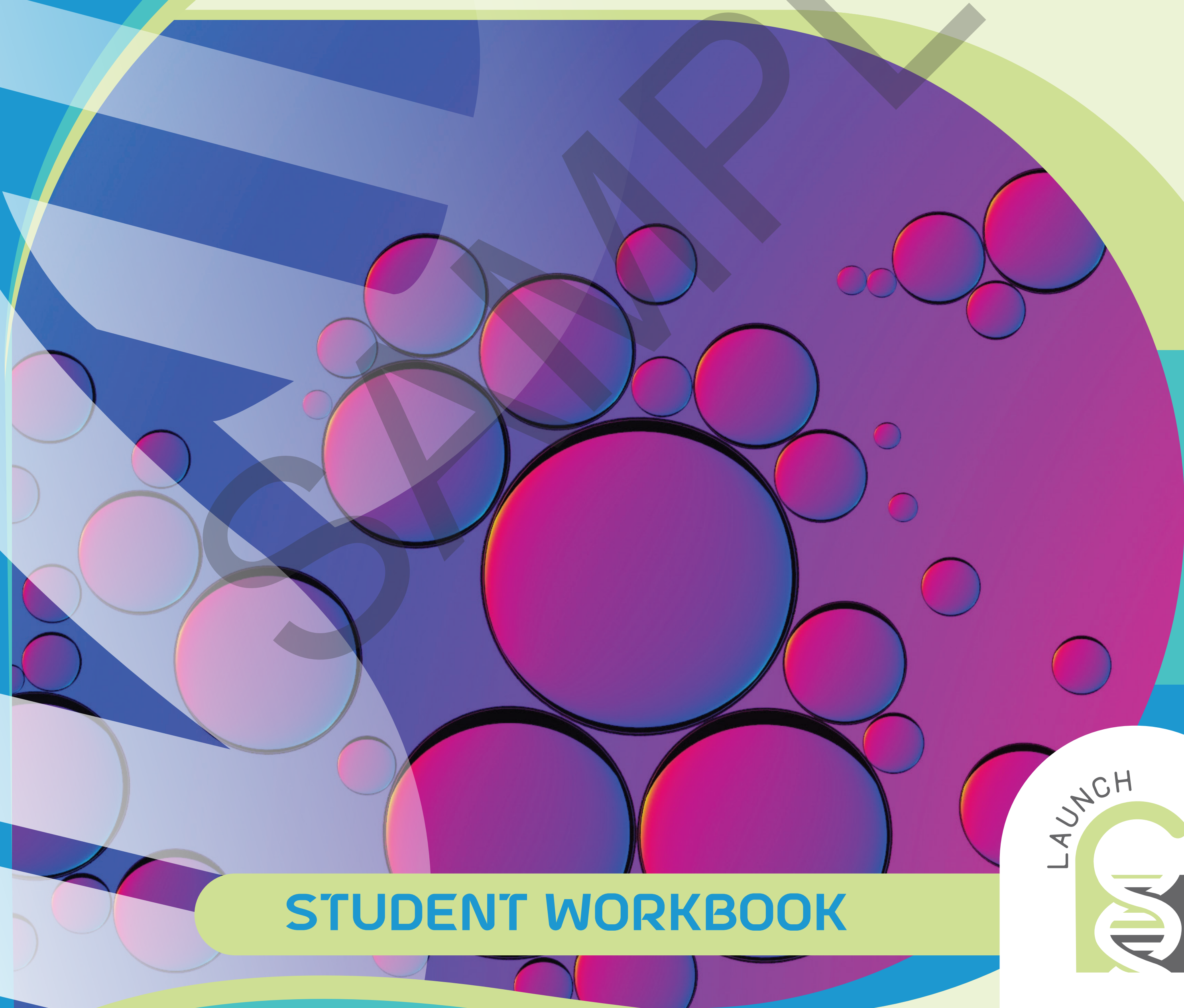
ATOMS AND ANGLES



STUDENT WORKBOOK

LAUNCH

ACTIVITY 1

BENDS AND BONDS

The hidden world of atoms and molecules can be surprising. Zoom in on the shapes of water and carbon dioxide particles to see how!

LEARNING GOALS:

- I can develop a model to describe the three-dimensional arrangements of atoms in molecules and explain the relationship between molecular geometry and the repulsion between electrons.

I BENT OUT OF SHAPE

Shaping Up

Water and carbon dioxide are two chemical compounds that are in and around you. The chemical formula of water is H_2O, meaning each molecule of water has two hydrogen atoms and one oxygen atom. A carbon dioxide molecule has two oxygen atoms and one carbon atom, and its formula is CO_2.

Because each of the two molecules has two of one atom and one of another, you might expect they would have similar shapes. Look at these models of the two compounds to find out if that's true.

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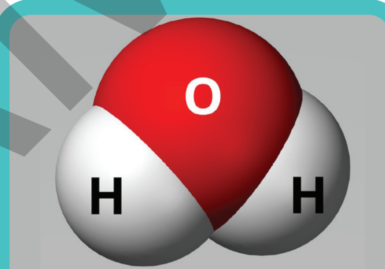
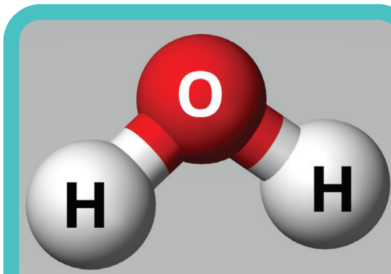
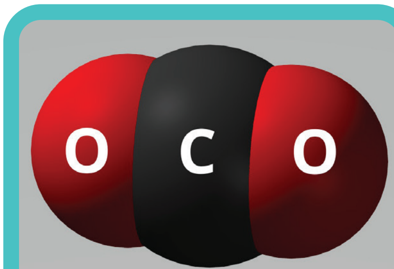
How do we know what the shapes of molecules are? One way is by performing analysis of their properties. For example, chemists determined water has a bent shape after examining its hydrogen-bonding behavior and crystal formations.



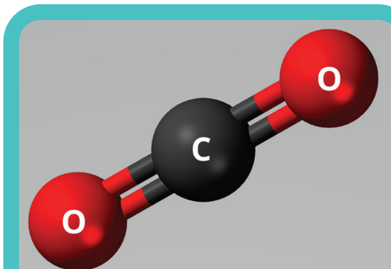
Water: space-filling model



Water: ball-and-stick model



Carbon dioxide: space-filling model



Carbon dioxide: ball-and-stick model

Why include two types of models of each molecule? Both models are useful in different situations. A space-filling model of a molecule shows the relative distance between the atoms in the molecule. A ball-and-stick model shows the bonds between the molecules.

A **bond** is an attraction between two atoms resulting in the formation of a chemical compound. A bond can either be covalent (two atoms share electrons) or ionic (one atom gives electrons to another).

Covalent bonds can be single, double, or triple, meaning two, four, or six electrons are shared, respectively. Single bonds are not as strong as double bonds, which are not as strong as triple bonds. The strength is affected by the number of electrons shared and the space between the atoms: two atoms that share a triple bond are much closer together in their molecule than two atoms sharing a single or even double bond.

Having both types of models allows for seeing both the bonds and the true shape of the molecules, including the distance between atoms. One major limitation of both models is that they don't accurately show the sizes of molecules because actual molecules are over a million times smaller than a single millimeter. They also don't show the true appearance of atoms because atoms have constantly moving electrons orbiting a small but dense nucleus.

MAKE USE OF YOUR OWN MOLECULAR MODELS:

If you have a standard molecular model set, such as the Deluxe Molecular Model Set from Home Science Tools, you can use it for this part by building some example molecules.

THINK ABOUT IT!

1. Why do you think a water molecule is not shaped in a straight line like carbon dioxide?

2. What do you think determines the shapes of molecules?

3. What questions do you have about these molecules?

THINK ABOUT IT!

1. Were there any patterns in which strips moved toward and away from each other? Explain.

2. Based on your experimental results, draw and label a model for the electrical charges on two pieces of tape that are pulled apart (i.e. a Top tape and Bottom tape). In other words, draw what you think is happening on the particle level.
Note: you will learn more about this in the next subsection, but this will help you identify and expand on your current ideas.

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Tiny but Strong

In the tape strips experiment, some strips moved toward each other and some moved away from each other. In everyday life, you might say they attract or repel. The experiment showcases specific types of attraction and repulsion. These forces represent the interaction between charged particles, which are electrons and protons. **Electrostatic attraction** is the attractive force between a proton and an electron. **Electrostatic repulsion** is the repulsive force between a proton and another proton, or an electron and another electron.

Recall that every atom has a nucleus that is positively charged because it contains protons (each with a charge of +1) and neutrons (each neutral or with a charge of 0). Electrons, which are negatively charged, move around the nucleus very quickly (about 1 % the speed of light). Electrons can be lost or gained by atoms, resulting in charged atoms, or ions.

ACTIVITY 5

PUT IT TOGETHER

Now that you have some understanding of organic and inorganic compounds, you'll get a chance to practice building a variety of molecules using molecular models.

LEARNING GOALS:

- I can develop a model to describe the three-dimensional arrangements of atoms in molecules and explain the relationship between molecular geometry and the repulsion between electrons.
- I can use models to name and describe the major types of organic molecules and determine their roles in society.

19 MODEL THE MOLECULES

Chromatography Climb

The molecular structure of a compound affects what it does in different solvents. In this experiment, you will observe what happens to two different dyes in a process called paper chromatography. Paper chromatography is the separation of a mixture by passing it through a thin sheet of absorbent paper.

WHAT YOU NEED:

FROM THE KIT:

- Modeling dough
- Toothpicks

FROM THE KIT:

- (Optional) Molecular model kit

SAFETY!

WARNING! DO NOT EAT OR DRINK anything in this kit.

WHAT TO DO:

You will be building several molecules throughout this activity. For each molecule:

- Draw a Lewis structure.
- Make a physical model of the molecule.
- Draw a ball-and-stick model of the molecule OR make a perspective drawing.
- Write the molecular geometry/VSEPR shape.
- Determine the polarity of each different bond based on electronegativity.
- Determine the overall polarity of the molecule.
- Decide whether the compound is organic or inorganic.