Atoms and Molecules

Have you ever built something from building blocks or Legos? You used small blocks of different shapes and sizes to make something bigger. Atoms and molecules are the same thing. They are the building blocks that make up all the things we see and feel around us.

The smallest drop of water you can get and still have it be water is called a molecule. If you break it up anymore, it won't be water anymore, just like if you break a cup of ice water into ice, water, and a cup, and then took away the ice and cup, it isn't a cup of ice water. Molecules must be very small, because all you can see is water, right? Right!

As small as molecules are, they can still be broken up into smaller pieces called atoms. There are lots of different kinds of atoms. Imagine having a large tub of building blocks. There are all different kinds of blocks- different sizes, colors, and shapes. These atoms go together in all kinds of different ways to make molecules. When you get enough molecules together, you have something you can see, like water.

TRY THIS QUICK EXAMPLE: Take the index card from your kit and cut it in half. Then cut one piece in half, then cut another piece in half, and so on and so on. If you could cut the paper into small enough pieces you would get down to a molecule and then if you could keep cutting you would get an atom.

Here are the activities we'll do as we investigate atoms and molecules:

1. A quick example (see above)
2. States of Matter
3. Let's Make a Molecule!
4. What A Change Cold Makes
5. What Is That Goop??
6. Molecules On The Move

The experiment kit contains:

1. An index card
2. A black sipper stick and 2 colors of modeling clay
3. 3 plastic bags and a glow-in-the-dark ball
4. 3 balloons
5. A cup, a craft stick and $\frac{1}{4}$ cup of cornstarch
6. 2 tea bags

States of Matter

Atoms and molecules make up something called matter. Matter is the stuff you see all around you- air, water, paper, just to name a few. They are all made of something.

So water is matter. Water can be made into ice by making it really cold in the freezer. You can turn it into steam when you get it really hot in the shower. What is different about water that is ice and water in your glass you can drink- they are both water, right? The difference is called the state of the matter. The ice is a solid, while the water you can drink is a liquid. The steam you get in the bathroom is a gas.

What you need:

1. An empty cup
2. 3 plastic bags
3. A pencil
4. A ball

What to do:

1. Put the ball in one of the plastic bags and close it. The ball is a “solid.”
2. Put about $\frac{1}{4}$ cup of water into one of the plastic bags. Water is a "liquid".
3. Blow air into the third empty baggie and close the bag. Air is a “gas.”
4. Look at each bag, and answer these questions:

Does what is inside the bag-

   a. Take up space?
   b. Can you see it?
   c. Does it have weight? (Is it heavy?)

5. Now open the bags, one at a time, and pour what is inside into the cup. Does what is inside the bag it keep its shape if you pour it into the cup? (Be sure to empty the cup after you test each thing!)
6. Use your answers to fill out the chart.

Properties of Matter				
	Holds its shape when I pour it in a cup	Takes up space	I can feel its weight	I can see it
Solid				
Liquid				
Gas				

What is going on? So why are there different states of matter?

There are different states of matter because the atoms and molecules that make up the matter are actually moving around. When they got hot, they move around a lot faster and push each other around. When they cool down, they slow down, and they can get closer together because they aren't pushing so much. A gas has molecules that move around a lot and push each other around. A liquid has molecules that still move around a lot, but not as much as a gas. The molecules of a solid don't move around all that much.

Let's Make a Molecule!

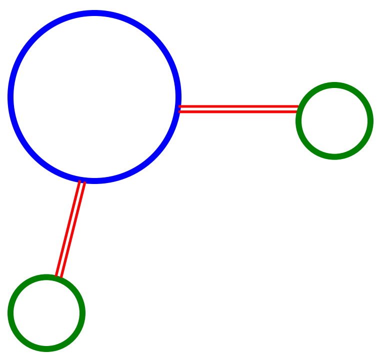
There are lots of different kinds of atoms. Just like building blocks, they join together to make different molecules. Let's make a molecule of our own.

What you need:

1. 2 colors of modeling clay
2. A brown sipper stick

What to do:

1. With one color of modeling clay, make two balls about the size of nickels.
2. With the second color of clay, make one larger ball- make sure it is bigger than the other two!
3. Now, cut your sipper stick into two pieces the same size. Put one on each side of the large ball of clay.
4. Now put a small clay ball on the end of each of the stick pieces coming out of the large ball. It should look something like this:



You just made a model of a water molecule! Your water molecule has two different kinds of atoms- called hydrogen and oxygen. A water molecule has 2 hydrogen atoms (the two small balls) and one oxygen atom (the larger ball). When you get enough of these molecules together, you have a glass of water!

Each type of atom has its own symbol, usually a letter or two from the atoms name. Scientists use the symbols for hydrogen (H) and oxygen(O) to write the recipe for water like this: H_2O

This means there are 2 hydrogen atoms and one oxygen atom (they just don't write the 1).

What a change cold makes!

What happens if you stop the molecules in a gas from moving around so much? How can you do that? Let's find out.

What you need:

1. Water
2. 3 balloons
3. One small empty bowl or cup

What to do:

1. Fill two balloons with water and have a grown-up tie them. Put one water-filled balloon in a small bowl or cup and put them into the refrigerator overnight. Put the other one in the freezer for at least one night.
2. Blow up the last balloon and have a grown-up tie it. Put this balloon in the fridge too. (This balloon is full of the gas you breathed out, and that gas has tiny bits of water in it.)
3. What do you think will happen to each balloon overnight?
   a. Balloon in the freezer:

   b. Balloon with water in the fridge:

   c. Balloon with air (gas) in the fridge:

4. After one night, take the balloons out of the fridge and freezer. What do they look like? How does each one feel?

   a. Balloon with water in the freezer:

   b. Balloon with water in the fridge:

   c. Balloon with air (gas) in the fridge:

5. Compare your predictions with your observations.

What is that goop??

Not all matter does what we think it should. It isn't always easy to tell if something is a liquid, a solid, or a gas. Have you ever turned a liquid into a solid just by tapping on it? In this experiment you make just such a liquid.

What you need:

- A plastic cup
- 1 craft stick
- $\frac{1}{4}$ cup of cornstarch
- Water
- Newspaper (a paper bag or a plastic bag are good substitutes)

LAB SAFETY: Do not wash the material you are about to make down the sink. Throw it in the trash!!

1. Place a sheet of newspaper flat on a table. Put the cup in the middle of the newspaper. Add $\frac{1}{4}$ cup of dry cornstarch to the cup. Add about 6 teaspoons (or just 6 spoonfuls) of water to the cornstarch and stir slowly. Add water slowly to the mixture, with stirring, until all of the powder is wet.
2. Your goal is to create a mixture that feels like a stiff liquid when you stir it *slowly*, but feels like a solid when you tap on it or squish it with your finger or the craft stick. If your mixture is too liquid, add more cornstarch. If it is powdery, add water.
3. Scoop or pour the cornstarch mixture into the palm of your hand, then slowly squeeze it into a ball. As long as you keep pressure on it by rubbing it between your hands, it stays solid. Stop rubbing, and it "melts" into a puddle in your palm. Can you think of other tests you can do with it?

What is happening?

Why does the cornstarch mixture behave like this? Think of a busy sidewalk. The easiest way to get through a crowd of people is to move slowly and find a path between people. If you just took a running start and headed straight for the crowd of people, you would slam into someone and you wouldn't get very far. This is similar to what happens in the cornstarch mixture. The solid cornstarch acts like a crowd of people. Pressing your finger slowly into the mixture allows the cornstarch to move out of the way, but tapping the mixture quickly doesn't allow the solid cornstarch particles to slide past each other and out of the way of your finger.

We use the term "viscosity" to describe how easily a liquid can flow. Water, which has a low viscosity, flows easily. Honey, at room temperature, has a higher viscosity and flows more slowly than water. But if you warm honey up, its viscosity drops, and it flows more easily. Most fluids behave like water and honey- their viscosity depends only on temperature. We call such fluids "Newtonian," since their behavior was first described by a very famous scientist called Isaac Newton. The cornstarch mixture you made is called "non-Newtonian" since its viscosity also depends on the force applied to the liquid (your tapping it) or how fast an object is moving through the liquid.

Other examples of non-Newtonian fluids include ketchup, silly putty, and quicksand. Quicksand is like the cornstarch mixture: if you struggle to escape quicksand, you apply pressure to it and it becomes hard, making it more difficult to escape. The recommended way to escape quicksand is to slowly move toward solid ground; you might also lie down on it, thus distributing your weight over a wider area and reducing the pressure. Ketchup is the opposite: its viscosity decreases under pressure. That's why shaking a bottle of ketchup makes it easier to pour.

NOTE: Isaac Newton was a member of a science club himself- The Royal Society of London for the Improvement of Natural Knowledge, or just the Royal Society. Look him up in your library or on the internet. You will find out how many neat things he discovered by being interested in math and science!

Molecules on the Move

Let's see what happens when molecules are heated up. We can actually see the movement of molecules by watching the way a tea bag colors water in a glass.

What you need:

- 1 clear glass
- 2 tea bags
- A cup of cold water
- A cup of hot water

Prediction: First, answer this question- do molecules move faster or slower when they are hot? What do you think happens to the movement of molecules in water when the water is heated?

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Now test your prediction:

1. Fill a glass half way with cold water. Let it sit on the table a few minutes until the water seems still.
2. Add one tea bag by gently dropping it into the water. Do not touch the glass!
3. Time how long it takes for the tea to color the water in the glass. Do this by counting or by using a clock, watch, or timer.

   What happens to the water color- does the tea make a pattern or color the water all at once?

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   How long did it take for the water to change color?

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4. Do you think there would be any difference if the water was hot?

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5. Try it. Rinse the glass then put some hot water in it. Let it sit on the table a few minutes until the water seems still.
6. Add the other tea bag. Do not stir or shake the glass.
7. Time how long it takes for the tea to color the water in the glass. Do this by counting or by using a clock, watch, or timer.

What happens to the water color- does the tea make a pattern or color the water all at once?

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How long did it take for the water to change color?

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CONCLUSION- compare your answers with your prediction

What happens to the movement of molecules in a substance (the water) when that substance is heated?

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Credit where credit is due….

The experiments, discussions, and pictures in this handout were taken or adapted from the following websites and books:

1. The States of Matter activities were adapted from classroom activities developed by:

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   Who used these references:

   Science on a Shoestring
   Scholastic's Big Science: Matter

   Here is the website: http://www.iit.edu/~smile/ph9516.html
2. What is that goop?? Was only slightly modified from the "lumpy liquids" experiment (http://scifun.chem.wisc.edu/homeexpts/lumpyliquids.htm) written by the master of chemical demonstrations, University of Wisconsin-Madison Chemistry Professor Bassam Z. Shakhashiri. He shares the fun of science through home science activities, demonstration shows, videos, and books. Information about these and other science fun stuff is available here: http://scifun.chem.wisc.edu/homeexpts. This is a great website!
3. The Molecules on the Move experiment was adapted from D. M. Candelora (Copyright 1996. All rights reserved. Reproduction for educational use is encouraged.) It was found at the following website: http://galaxy.net/~k12/matter/

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