# Interactive Notes-"States Of Matter"

**Materials (per group of 4 students):**

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| Demo 1 | 1- zipper bag with 2 spoonfuls of sodium hydrogen carbonate (baking soda)<br>25ml –acetic acid (vinegar)- in a closed container (to avoid spills) |
| Demo 2 | 1-penny<br>1-dropper<br>1-narrow-neck bottle (the penny must cover the entire opening)<br>1-600ml (or larger) beaker |
| Demo 3 | 1-250 ml beaker- half-filled with ice water |
| Demo 4 | 1-dropper with food coloring (any dark color); placed in a plastic bag so it won't leak |
| …and | 4-note sheets (see p. 7) |

**Additional Teacher Materials:**

PowerPoint (see p. 7)
4-1000ml flasks of near-boiling water
1-pair- hot gloves
cooler with ice
2 tennis balls (optional)

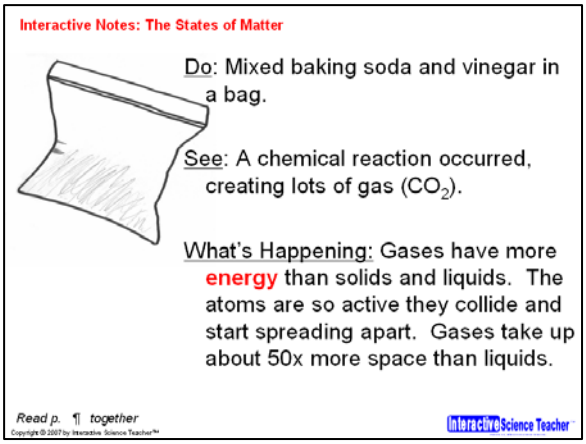
**Beforehand:**

- Set out all materials *the day before*. This one will take longer to set up for than you might expect. Leave yourself time to realize you're missing something, and to practice a new demonstration, research something or even make a change. In the morning, read through the slides and notes one last time. Relax and have fun along with your students. Remember- you're only as effective as your plan.
- Insert page and paragraph numbers from relevant pages in your textbook at the bottom of slides 1 and 2 if you choose to have the class read from it together. This is a good way to connect with your textbook as well as transition into the next demo. You can also delete these page inserts, or Copy and Paste them onto later slides if needed.
- As with any other demonstration, try these out ahead of time for yourself so you know how they work best and so you know what to expect.
- Print extra copies of the notes pages on paper for yourself, students that are slow writers or can't see well, and for absentees. Click "File" → "Print" → then where it says "Print what:" select "Handouts" → and then "OK".
- In preparation for demo #1 it would be a *very* good idea to get all the baggies with baking soda ready the day before, and all (or as many of) the 25-mL of vinegar vials poured. You've got better things to do during notes day than to deal with these. Pour about 5 extra of each also- you'll need them for one reason or another.

*Things to do the morning of*:

- Put 4- 1000ml flasks of water on a hot plate to 225˚ Celsius about an hour before your first class. This is enough hot water to last 2 classes. *NEVER leave a dry flask/beaker on a hot plate, and make sure you turn it off at the end of the day.*
- Fill the cooler with ice. Just before your first class comes in put the ice and water in the 250 mL beaker for each group.

1.




Have student #1 (of the 4) pour vinegar into the bag of baking soda and quickly seal it shut, trapping all the gas.

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This is a good introductory demo because it involves all three states and gives you a chance to mention anything you want to about any of them.

It's fun to tease students at the beginning by telling them, with great caution in your voice, to be careful handling the explosive sodium hydrogen carbonate. Smile and tell them its common name- baking soda. Then try and do the same with acetic acid (vinegar).

Before students pour in the vinegar to begin the reaction, have them first zip the bag halfway shut which will allow them to close it quicker and with more ease.

Regular sandwich bags do a good job in this demo, but some will leak air and liquid. Freezer bags (quart size) do a better job.

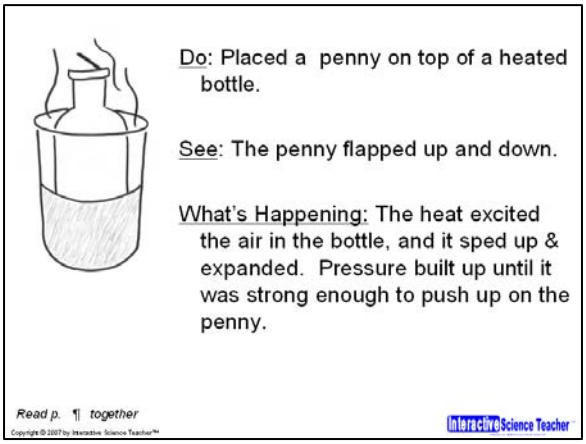
When you get to the last section of the notes, remind students how small their powder initially was, and so was their liquid. Then look at the bag full of air!

After the demo tell students to not open the bag and release the air. We'll need it inflated for demo #3.

This demo would also be a good time to introduce them to the concept of a chemical change (Where's the baking soda and vinegar? Long gone!). On top of that, have them feel the bag as the reaction happens (it's cold!). This is an endothermic chemical reaction, which needs heat from its surroundings to occur. When you touched it and it felt cold, some of your heat caused that reaction to happen.

The chemical formula for the reaction: $CH_3COOH + NaHCO_3 \rightarrow CO_2 + NaCO_3 + H_2O$

2.




Tell student #2 to put the bottle inside the 600ml beaker, and then put the penny on top, covering its mouth. Then have them fill the dropper with water from the ice water beaker and squirt water 2 droppers on top of the penny. This does 2 things- 1.) seals the penny better to the mouth of the bottle, and 2.) allows you to see bubbles escaping (so you can fix)

Take the flask of near-boiling water to each student setup and slowly pour the water into the larger beaker that surrounds the bottle. Stop pouring when it's a little more than half full. Any more than half and the bottle will lean to one side, causing the penny to slide off. (Even a tiny opening will allow the expanding gases to escape, and the penny will not dance.) *Caution: pour very carefully- boiling water will burn skin!* Tell students to keep the penny centered if it slides off the mouth and to keep water around the penny (squirt more if needed).

When it's working properly the penny will flap and dance up and down as the air inside the bottle below it heats, expands, and finally builds enough pressure to push up briefly on the penny. It can go on for several minutes and flap as many as 100 times!

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The reason for the tennis balls is so you can show your students what the atoms are doing. Set the two balls next to each other. They stay put. Now roll them towards each other over and over, each time rolling them harder (this is energy going in, causing them to move faster). What do they do? They collide, and bounce off each other. And the faster they are going, the more forcefully they collide, and the more spread apart they get. That will show your students exactly how gases behave.

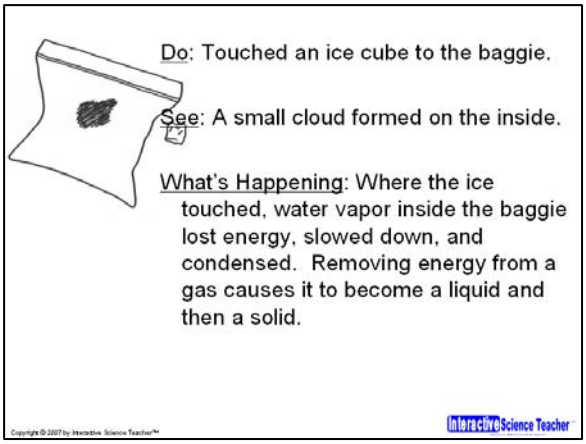
The perfect bottle for this is made of glass (so it has some weight) and has a mouth just wide enough that a penny will just cover it. It should also have a body that fits inside a large beaker so it can be surrounded with hot water. If you don't have any, go to a convenience store and look in their refrigerated section for a glass juice bottle that looks like it could work.

If the opening of the bottle is too big for a penny, **quarters work equally well**.

You'll need 2- 1000ml flasks of near-boiling water per class (8 groups per class). Immediately refill the flasks as you empty them during class so they'll be ready again in 2 class periods. Set the hot plates to 225˚ Celsius. The other 2 unused ones are for next class.

**Practice this one ahead of time so you know how it works best. It can be tricky to get at first, but once you learn it you can pull it off every time, and it will become one of your favorites.**

3.




Have student #3 take an ice cube from the ice water and touch it to the outside of the baggie from demo #1. If they move it all over, the whole bag will fog on the inside.

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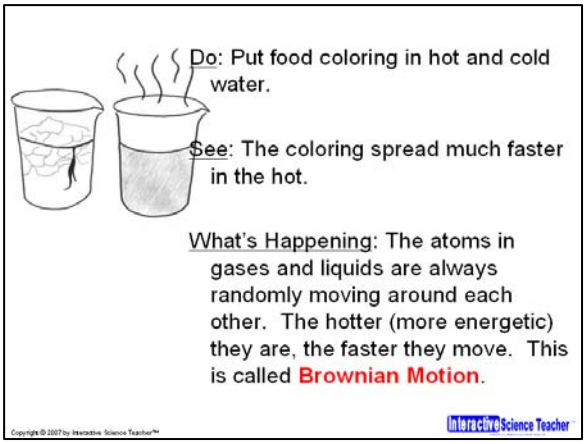
There are two big ideas at the foundation of this. The first is that the atoms themselves never change, just how active they are. Inside the bag water as a gas condensed into tiny liquid droplets. It never stopped being water. The other is how atoms change between states. Heating excites atoms and causes solids to become liquids, and eventually liquids to become gases. Cooling has the opposite effect by removing energy and thus slowing the atoms back down.

This would be a great time to talk about the life of a molecule of water. Outside right now you're a vapor, but tonight it's going to get cold, so you'll slow down and condense into a liquid (dew). If it gets really cold you'll freeze (frost). Then the sun will come out and its energy will turn you back into a liquid, then a vapor again. This is your life, day after day. All you ever do is speed up and slow down, based on heat from the sun.

4.




Have student #4 take the bottle from demo #2 out of the large beaker and then put the beaker with ice water next to it. Then have them put 4 drops of food coloring into each beaker then just observe what each does without touching either beaker.

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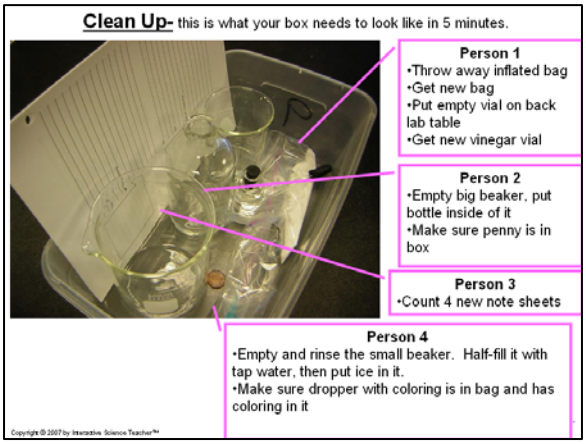
Warn students about keeping their stained hands away from their clothing. Have a towel handy or let them wash hands during class if needed.

There are several points you'll want to make: atoms, too small to see, are moving around in there; they never stop moving; the cold mixes, though slower, so its atoms must be moving slower than the hot. And the hot mixes faster because its atoms are moving that much faster.

If you have a particularly sharp class ask them why hot things are hot, and cold things are cold, as in the case of this water. The same water came out of the faucet, but what makes the hot hot and the cold cold? Well, when atoms move around they collide with each other. The faster they move, the harder they collide. And when they collide, there's friction, just like when you rub your hands together. The faster you rub your hands together, the more friction, so the more heat. The faster the atoms of water go, the harder they collide, and the more friction, causing heat, they give off.

It's also fun to go a little ways into the issue of Brownian motion, named for Robert Brown, who correctly said the movement of atoms in a fluid (including both liquids and gases) are completely random.

http://galileo.phys.virginia.edu/classes/109N/more_stuff/Applets/brownian/brownian.html




You'll need at least 5 minutes to reset everything for the next class.

Leave refills of everything in different parts of the back of your room so students don't all crowd one spot:

- Pre-poured baking soda bags (2 spoons/scoops)
- Pre-poured vinegar bottles (25 mL)
- Ice
- Note sheets

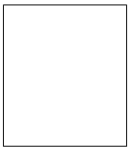
- You'll also want to keep extra food coloring somewhere for when students need to refill. Better not leave that out, though.

If you don't want this slide to show, right-click on the slide and select "Hide Slide".

To help you with clean up, have your last science class take everything out of the boxes and put them in like piles in the back of your room.

# Student Handout

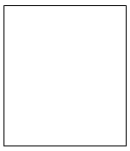
Topic: _____ Date: ___/___/___



Do: _____

See: _____

What's happening: _____



Do: _____

See: _____

What's happening: _____