



Teacher's Guide

For the Museum on the Go's

"What's the Matter?" Program

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LETTER TO TEACHER OR EDUCATOR

The Museum on the Go is coming to your school! We will be talking about all of the "stuff" around us. What is that "stuff"? It is matter. Different kinds of matter behave differently and sometimes matter can change its state

The Museum on the Go will be presenting the states of matter and demonstrating how matter changes when energy in the form of heat is added or taken away from it. During the Museum visit, children will observe, explore and investigate the properties of different states of matter through several hands-on exhibits and facilitated inquiry. We will begin each class session with a few demonstrations by the Museum on the Go staff where we will explain the "magic" behind the demonstrations. After a brief introduction to our hands-on exhibits, the students will have approximately 20 minutes of free exploration. We will end the class session with a closing demonstration.

To help get you and your students excited about the science of the states of matter and how they can change, we have provided you with some key vocabulary, fun facts about the states of matter, physical and chemical changes and molecular movement along with a few demonstrations that you can do in the classroom before and after the Museum's visit to explore these concepts.

Think of ways to extend the activities to complement your current curriculum and don't hesitate to share any great ideas with us. Send your ideas to theresa@cmosc.org

Get excited about science!

Please don't hesitate to call me if you have questions. I look forward to seeing you and your students soon.

Theresa Giacomino,

Director of Education and Programs

theresa@cmosc.org

707-338-3412

VOCABULARY

Some words relating to the states of matter with Spanish translations

Atom-átomo	Matter-materia
Boiling Point- punto de ebullición	Melting point- punto de fusión
Chemical reaction- la reacción química	Phase-fase
Condensation- condensación	Physical reaction- reacción física
Density- densidad	Plasma-plasma
Element- elemento	Property-propiedad
Energy_energía	Solid- sólido
Evaporation- evaporación	State-estado
Freezing point- punto de congelación	Vapor-vapor
Gas-gas	Volume-volumen
Liquid-liquido	Molecule-molécula
Mass-misa	

Can you think of any more?

Atom-átomo : a unit of matter, the smallest unit of an element, having all the characteristics of that element and consisting of a dense, central, positively charged nucleus surrounded by a system of electrons.

Boiling Point- punto de ebullición: the temperature that a liquid becomes a gas. This happens when energy is added to the liquid.

Chemical reaction- la reacción química: when a chemical change occurs and a new substance is formed.

Condensation- condensación: the phase change when a gas cools back into a liquid. The opposite of evaporation.

Density- densidad: the measure of how much mass is a given volume or how much "stuff" is in something.

Element- elemento: substances that cannot be separated into simpler substances.

Energy_energía: energy in the form of heat is needed to change from one phase to another.

Evaporation- evaporación: the phase change when a liquid gains enough energy to change into a gas.

Freezing point- punto de congelación: the temperature at which a liquid becomes a solid. This happens when energy is removed and a liquid is cooled.

Gas-gas: one state, or phase, of matter. A gas is easy to compress, spreads out evenly to fill out a container of any size and shape, and its atoms have more energy than liquids or solids.

Liquid-liquido: one state, or phase, of matter that exists between the solid phase and gas phase. A liquid is hard to compress, takes the shape of the part of the container it is in, and its atoms have more energy than a solid but less than a gas.

Mass-misa: amount of matter there is in something.

Matter-materia: anything that takes up space and has mass. All of the "stuff" around us. Anything that is made of atoms and molecules.

Melting point- punto de fusión: the temperature at which a solid becomes a liquid. this happens when energy is given to it in the form of heat.

Phase-fase: a physical condition or stage of matter. Another word for phase is "state."

Physical reaction- reacción física: when the physical properties of matter are changed. It has not changed its chemical make-up. If you freeze water it is still water.

Plasma-plasma: considered a 4th state of matter. Plasma is a lot like gas but is made up of free electrons and ions. Electricity (a form of energy) flowing through the gas in a neon sign, or a fluorescent light make plasma in those lights.

Property-propiedad: describes how an object looks, feels and acts.

Solid- sólido: one state, or phase, of matter that is hard to compress, holds a shape, has a certain size, and might be hard. Atoms in solids don't move very much.

State-estado: a physical condition or stage of matter. Another word for state is "phase."

Vapor-vapor: another word for gas. Vapor is the word used to describe gases that are usually found as liquids, such as water.

Volume-volumen: the amount of space an object occupies.

Molecule-molécula: the smallest particle of a substance that retains the chemical and physical properties of the substance and is composed of two or more atoms.

FUN FACTS

(all demonstrations are attached)

FACT 1 ***Matter is the "stuff" all around us. It can come in different states.***

Activity 1: States of Matter scavenger hunt. Go on a scavenger hunt around your house or classroom for different states of matter. This is a great observation and vocabulary activity.

Activity 2: Paint with Melting Ice Cubes Explore water as a solid, liquid and gas and compare how different temperatures throughout the day will affect this fabulous matter.

FACT 2 ***Matter has mass and takes up space.***

Demonstration 3: Will it Dissolve? Make a solution with sugar and water and a mixture with dirt and water. Test variables and make predictions.

FACT 3 ***Density is an important physical property of matter. Density=Mass/Volume.***

Demonstration 4: Liquid layers. Oil and water have different densities. Oil floats on water because it is less dense than water. Explore the different density of liquids right on your desk.

FACT 4 ***Matter is made up of tiny particles called atoms. Atoms bond together to form molecules that make up all matter. Molecules are always on the move. The movement of these molecules determines what state the matter is in.***

Demonstration 5: Mix Without Stirring. Molecules are always on the move. The more energy they are given, the faster they move. "See" molecules stir water of different temperatures.

Demonstration 6: Molecule Phase Dance. Become molecules and take on their properties as you change states in the "Molecule Phase Dance."

FACT 5 ***Matter can change from one state to another. The changes are physical changes and chemical changes.***

Demonstration 7: Can Crusher. This demonstration was done by the Museum-on-the-Go staff when they visited your school. Or maybe we haven't been there yet. Please save this activity for after we present it. You will want to do it again!

Demonstration 8: Dancing Raisins. Sometimes mixing things together causes a chemical reaction. Observe a chemical reaction and see how the result can make raisins dance.

Demonstration 1: States of Matter Scavenger Hunt (grades K-4)

Some things to wonder about before starting the activity:

What is matter? What are the states of matter?

Matter is all of the "stuff" around us. Everything you can see, smell, taste and touch is made of matter. Even the air is matter. It comes in different states or phases. For this activity we will focus on the most common states of matter that are around us: solids, liquids, and gases.

Matter can even change from one state to another and sometimes back again. We will explore that in later activities and demonstrations.

What kind of matter can you find? What state is it in?

What you need for this activity:

- Pencil, clipboard, worksheet (on page 7)
- space to look for different matter (classroom, playground, home, etc.)

What to do:

1. Have discussion about what the states of matter are. A couple of images are included on the next page with their URL below each image.
2. Working independently or in a group, take a walk around your designated space. List all of the matter you can name and determine what state it is in.
3. Share your findings with the other students.

What's happening:

Matter comes in different states or phases. Matter has certain properties.

How would you describe some of the matter that you discovered?

Did you make any new discoveries?

Did you find any matter that didn't seem to fit just one state?

Can you come up with a list of vocabulary words based on the matter you found?

More to do:

Play with Ooblech and Gak. Both are interesting in that they behave like solids and liquids depending on the pressure they are given. Ketchup is another substance that behaves like a solid and liquid. Follow the links below to find good recipes for Ooblech and Gak

For Ooblech and an all around good site to search for fun experiments:

<http://chemistry.about.com/od/chemistryhowtoguide/ht/oobleck.htm>

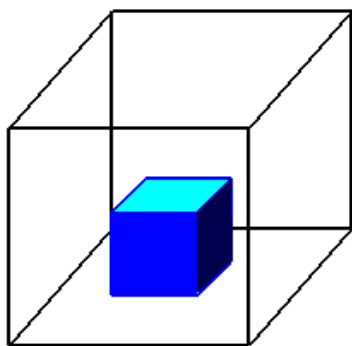
For Gak and a fantastic website for ideas and products:

<http://www.stevespanglerscience.com/experiment/00000039>



States of Matter

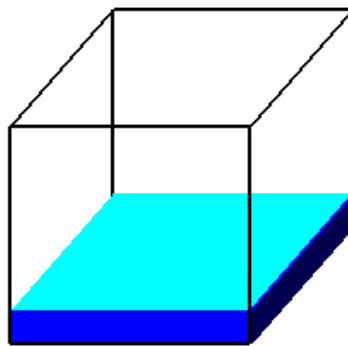
Glenn
Research
Center



Solid

Holds Shape

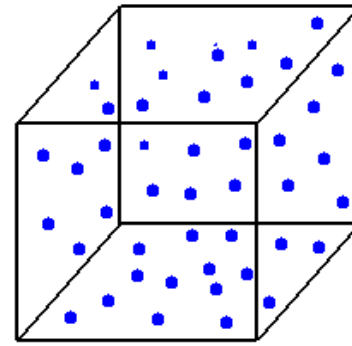
Fixed Volume



Liquid

Shape of Container
Free Surface

Fixed Volume

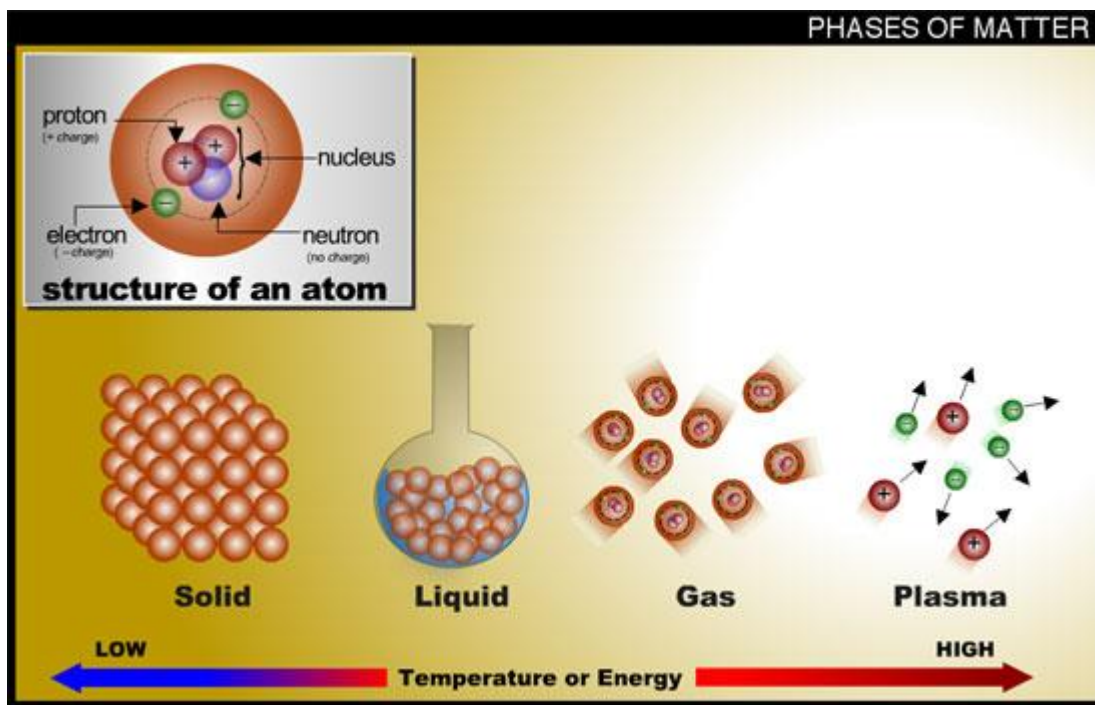


Gas

Shape of Container

Volume of Container

[**http://sjesci.wikispaces.com/file/view/StatesOfMatter.gif/146334781/StatesOfMatter.gif](http://sjesci.wikispaces.com/file/view/StatesOfMatter.gif/146334781/StatesOfMatter.gif)



[**http://www.freewebs.com/mscase//Matter/147515main_phases_large.jpg](http://www.freewebs.com/mscase//Matter/147515main_phases_large.jpg)

States of Matter

What are the three states of matter according to their properties?

_____ hold their shape.

_____ take the shape of the bottom of their container.

_____ take on the shape of their container and spread out.

Take a field trip around the classroom or playground and list all of the states of matter that you can find.

Solids	Liquids	Gases
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Was there anything that you found that did not fit into just one category? What was it?

Is there anything else that you can think of that does not fit into just one state of matter? _____

There is a fourth state of matter. Do you know what it is?

Demonstration 2: Melting Ice Cubes and Disappearing Paint

Some things to wonder about before starting the activity:

What is an ice cube made of? What state of matter is it? Can water come in different states? How does it change from one state to another?

Water is pretty amazing stuff. It can exist in all 3 states. In this activity you will be able to see it changing before your eyes.

What you need for this activity:

- Ice cubes-enough for students to have a couple of ice cubes apiece.
- Different surfaces to observe the melting process. Try metal, foam, plastic, desktops, etc.
- cup for ice cubes to go outside
- paint brush
- sunny day

What to do:

1. Have a discussion about water and what the students' experience with water is. Ask them if they know what H₂O is. Even some of the youngest kids have heard of H₂O before. This will just introduce them to molecules. The states of matter depend on the physical state of atoms and molecules.
2. Give everyone an ice cube. Observe the ice cubes and how they melt on different surfaces. What's making them melt?
3. Go out onto the playground with your ice cubes, cup and a paint brush.
4. Using your ice cube/liquid water as paint, paint your name or a design on the ground. What happens to the marks that you have made? How long did it take for the ice to melt? How long did it take for the liquid to evaporate?
5. Share your findings with the other students.

What's happening:

When energy is added or taken away from matter, it can change states. The energy excites the atoms and causes them to move and change the state of the matter. This energy is in the form of heat. Ice cubes melt into a liquid and the liquid evaporates into a gas. In this case we saw water in the form of a solid (ice cube) melt when heat was given to it. It changed into a liquid. We also saw the liquid change into a gas when heat was given to it and it evaporated.

These are physical changes. The water is still water, or H₂O, in all of these states. The water is also going through reversible changes meaning that they can change back into the previous states it was in and still be H₂O.

Observing the ice melt on different surfaces demonstrates the surface's conductivity or how well heat is taken away from the ice cube. You can time the different melting rates on different surfaces and in different environments.

Where did the heat come from in this activity?

What other sources of heat could we use?

What would happen if you did this activity on a cloudy or foggy day?

Demonstration 3: Will it Dissolve?

Some things to wonder about before starting the activity:

Can you mix a solid and a liquid together?

Can you think of something that dissolves in water?

Can you think of something that does not dissolve in water?

Sugar can dissolve in water. How much sugar can you dissolve in a half cup of water? In this activity, you will find out how much sugar can "fit" in the water.

Dirt cannot dissolve in water. In this activity, you will play with dirt and water in a couple of different ways.

What you need for this activity:

- "Will it Dissolve" Worksheet (downloadable from http://www.cmosc.org/school_programs.html)
- Sugar
- Water of 3 different temperatures (cold, warm and hot)
- Thermometers if available to measure temp of water
- Measuring cups and spoons (Use liquid measuring cup and tablespoons)
- Cups larger than 1/2 cup or bowls to mix your solution
- Spoons for mixing
- Kool aid (optional)
- Dirt (not for consumption)

What to do:

1. Have a discussion about what can dissolve in water and what cannot. List everyone's ideas.
2. Read the worksheet with your students and have them make predictions about the different solutions they will be making. You can record these predictions if desired.
3. The temperature of the water can vary with what you have available. If you can cool it down in a refrigerator, Great! Use cold water from the fridge or ice water, water at room temperature and then water that you just boiled (200°). Please use caution with the "hot" water. What's important here is that these variables do not change between solutions. Use of a thermometer is recommended.
4. Using the worksheet on the following page, experiment with the solubility of sugar and dirt.
5. Share your findings with the other students.

What's happening:

A solution is a homogenous mixture of two or more substances. A saturation is a solution at a point where no more of the solute can be dissolved in the solvent.

You have mixed sugar with water at different temperatures. Most of it was able to dissolve into the water. When you reached a point that the sugar would no longer dissolve in the water, you reached its saturation point.

When you used dirt in this experiment, it never fully dissolved in the water. This was not a solution but rather a mixture or suspension. Let it stand and it will eventually separate.

More to do and some questions to ask your students:

What does the temperature of the water have to do with the point of saturation?

Predict whether or not the solutions you make will measure the same as the 1/2 cup of water you started with.

Measure the solutions once they are made. Do they still equal the 1/2 cup of water that you started with?

Try making two solutions with the same exact measurements of both the sugar and the water but this time stir one and let the other just sit. This will demonstrate how stirring aids in the dissolving process. Try it again with a different temperature of water.

Follow up with "Mix Without Stirring Experiment" on page 14

A great website for more information on solutions:

<http://www.chemtutor.com/solution.htm>

A great activity to demonstrate something that is insoluble in water can be found at.

<http://www.stevespanglerscience.com/experiment/00000032>

Makes a great art project. Ooooo...art and science together.

Demonstration 4: Liquid Layers

Some things to wonder about before starting the activity:

Why does some liquid float on other liquid?

Have you ever seen the "rainbow" slicks on puddles in the road? What is it?

Oil is less dense than water so it floats. Oil makes the "rainbow" slicks you may have seen on puddles before. Oil and water do not mix. That is why you have to shake the salad dressing before you put it on your salad.

Can you think of other liquids that don't mix with each other?

What you need for this activity:

- Plastic cups (4)
- clear straw
- plasticine clay (Fimo or Sculpey)
- eye dropper or pipette
- rubbing alcohol
- salt
- glycerin (find at Target or Walmart or other pharmacy)
- water
- food coloring
- measuring cup
- tablespoon

What to do:

1. Have a discussion about density. Density is how much stuff is packed into a certain amount of space. Lead is very dense; styrofoam is not very dense.
2. Explain that the class will be exploring the different densities of liquids in this demonstration. Solids and gases have different densities too.
3. Put out 4 cups to fill and share:
 - 1/4 cup water in one cup
 - 1/4 cup alcohol in one cup
 - 1/4 cup glycerin in one cup
 - 1/4 cup water and 2 Tbsp. salt in one cup
4. Make each cup a different color by adding food coloring and mixing
5. Push a straw into a lump of clay on your desk.
6. Use eye dropper or pipette to drop liquids from cups into the straw.

Experiment: Can you get the liquids to float on top of each other so that you see four different colors?

Hint: Each liquid has a different density.

What's happening:

Density is the how much stuff or matter is packed into a certain amount of space.

Helium is a good example of a gas that is less dense than the air we breathe.

More to do and some questions to ask your students:

Make some salad dressing with vinegar and oil. Observe the different densities of these liquids. Which is the denser of the two?

Try comparing a rubber super ball to a styrofoam ball of the same size. They are the same size but the rubber ball has more stuff or matter than the styrofoam ball. Can you find other items around you to demonstrate their different densities?

Try blowing up a balloon with your breath and then compare it to a helium balloon. Helium is less dense than our own air. Our breathe sinks below it like vinegar sinks under the oil in salad dressing.

Weigh different things that are the same size. The balls you compared are a good example of items to use.

Liquids Layers activity retrieved from the Science Museum of Minnesota website at:

<http://www.thinkingfountain.org/l/liquidlayers/liquidlayers.html>

Demonstration 5: Mix Without Stirring

Some things to wonder about before starting the activity:

How can you mix things together without stirring them?

When you made the solutions in “**Demonstration 3: Will it Dissolve?**”, what did you notice? This demonstration is very similar to that one but this time you are paying attention to what will happen without stirring it with a spoon.

Make predictions along the way about what you think will happen to each cup of water.

What you need for this activity:

- Plastic cups (3)
- Water at 3 different temperatures (ice cold, room temperature, very hot)
- Kool-aid powder or food coloring if you don't plan to drink your experiment.
- Sugar and ice (if you plan on drinking your experiment)

What to do:

1. Review the experiences from “**Demonstration 3: Will it Dissolve.**”
2. Set up three cups of water: one with hot water, one room temp. water, one with ice cold water.
3. Predict which one will spread the Kool-aid powder or food coloring the fastest, the next fastest and the slowest.
2. Add a pinch of Kool Aid powder or drop of food coloring to each cup.
3. Record what happens.
4. Mix all of the cups together, add some sugar and ice and enjoy a cool beverage.

What's happening:

Molecules are always on the move. The hotter something is, the faster the molecules that make up that something are moving. The H₂O molecules are what are stirring the color into the water.

More to do and some questions to ask your students:

Try the experiment with Kool-Aid and then do it again with food coloring. Did the solid or the liquid mix faster?

Demonstration 6: Molecule Dance

Some things to wonder about before starting the activity:

What are atoms and molecules? What do they have to do with the state of matter?

How does matter change and what is the vocabulary associated with those changes?

Refer to the images on page 3 to demonstrate the arrangement of molecules in solids, liquids, gases.

What you need for this activity:

- Basic understanding the fact that atoms and molecules make up all matter
- Basic understanding of the states of matter and the vocabulary of the changes that can occur (solid, liquid, gas, evaporation, condensation)
- Students
- Large open space of a determined size to move around. You can call this area the container your matter is in.
- Big voice to say commands or cards with commands written (solid, liquid, gas, condensation, evaporation, add heat, take away heat)

What to do:

1. Have a discussion about the states of matter and what makes up matter. Explain that the properties of matter are determined by the arrangement of their molecules. The states of matter depends on how fast or slow the molecules are moving.
2. Discuss some of the vocabulary involved with the changing states of matter. These terms are included on the vocabulary section on page 7.
2. A good demonstration to lead into this activity is "**Mix Without Stirring**" on page 14
3. Start the "**Molecule Dance**." Assemble in your designated space. Have the students become molecules of water. H₂O is a molecule of water that is probably familiar to most students. The water cycle is also something they may have prior knowledge of.

Rules of the game:

Commands to call out to students

- **Solid**-Solid water is ice and doesn't have much movement. Student will stay in one place and might choose to vibrate ever so slightly.
- **Liquid**-Liquid water is made of molecules that move more freely so students will walk around each other and might keep to one end of the area or the bottom of the container.
- **Gas**- Gases are made of more excited molecules and move around quickly covering the entire space. They could gently bump into each other and might event escape from the area or the container.
- **Evaporation**-A liquid will turn into a gas
- **Condensation**-A gas will turn into a liquid
- **Add heat**-change from one state to another. Students need to know which state to change into.
- **Take away heat**-change from one state to another. Students need to know which state to change into.

What's happening:

Atoms bond together to form molecules. Molecules are what make up any given matter. H₂O is a molecule of water. There are two hydrogen atoms and one oxygen atom that are bonded to make up one molecule of water. Different atoms combine to make different molecules and therefore different matter. The movement of molecules, how fast or slow, determine what state the matter is in.

When energy in the form of heat is added or taken away from matter, it can change states.

More to do and some questions to ask your students:

At extremely high temperatures, matter can lose all of its electrons. This matter is called plasma. Plasmas can be introduced as the fourth state of matter. It is not the same plasma that is in blood. This plasma is air that's made by lightning and is found in stars like our sun. Although we don't hear much about plasma, it is the most abundant state of matter in the universe. For more information on plasmas, go to: <http://www.plasmas.org/what-are-plasmas.htm>

Try adding a movement for plasma to the dance. What might it look like?

You can introduce Bose-Einstein condensates at this point. A Bose-Einstein condensate exists at the coldest temperatures of the universe. It is considered the fifth state of matter that only exists in a laboratory. If you understand that the molecules in matter get excited when energy is added and can then change states, a Bose-Einstein condensate is made of super unexcited atoms that are even less excited than molecules in a solid. What's super cool about this state of matter is that it was only a theory in 1924 but became a reality in 1995. For more information on Bose-Einstein condensates go to: <http://www.colorado.edu/physics/2000/bec/>

Try adding a movement for Bose-Einstein condensate to the dance. What might it look like?

This activity was adapted from an activity from Scholastic online. You can find more lessons on the states of matter there as well. <http://www2.scholastic.com/browse/lessonplan.jsp?id=1084>

Demonstration 7: Can Crusher (Physical change)

Some things to wonder about before starting the activity:

What is the state of matter of the aluminum can? Can we change its state? How?

What can you do with a soda can? Can you change its shape? How?

How can you crush it without using your own body as the force?

What's the difference between a physical change and a chemical change?

What you need for this activity:

Safety warning: You will be using a stove or hot plate to do this demonstration. Please have an adult do the demo and use the utmost caution.

- Empty soda cans
- Stove or hot plate
- Cooking tongs
- Gloves
- Lg. mixing Bowl
- Cold water

What to do:

1. Start by rinsing out the soda cans to remove any leftover soda.
2. Fill the bowl with cold water (the colder the better).
3. Add one generous tablespoon of water to the empty soda can (just enough to cover the bottom of the can).
4. Place the can on the burner of the stove while it is in the "OFF" position. It's time for that adult to turn on the burner to heat the water. Soon you'll hear the bubbling sound of the water boiling and you'll see the water vapor rising from the can. Continue heating the can for one more minute.
5. It's important to think through this next part before you do it. Here's what's going to happen: you're going to use the tongs to lift the can off the burner, turn it upside down, and plunge the mouth of the can down into the bowl of water.
6. Get a good grip on the can near its bottom with the tongs held so that your hand is in the palm up position. Using one swift motion, lift the can off the burner, turn it upside down, and plunge it into the cold water. Don't hesitate... just do it!
7. Wow... and you thought that you had nerves of steel. The can literally imploded. How does that work?
8. Don't just sit there... get back to that stove and do it again! Each time you repeat the experiment, carefully observe what is happening in order to try to figure out how it works.

What's happening

Here's the real scoop on the science of the imploding can. Before heating, the can was filled with water and air. By boiling the water, the water changed states from a liquid to a gas. This gas is called water vapor. The water vapor pushed the air that was originally inside the can out into the atmosphere. When the can was turned upside down and placed in the water, the water vapor condensed and turned back into the water. Water molecules in the liquid state are many times closer together than molecules in the gas state. All of the water vapor that filled up the inside of the can turned into only a drop or two of liquid, which took up much less space.

This small amount of water cannot exert much pressure on the inside walls of the can, so the pressure of the air pushing from the outside of the can is great enough to crush it. The sudden collapsing of an object toward its center is called an *implosion*. Nature wants things to be in a state of equilibrium or balance. To make the internal pressure of the can balance with the external pressure on the can, the can implodes. Hey, air pressure is powerful! One more thing... if you watch very closely when you turn the can upside down, you'll see that the cold water in the bowl shoots up into the can. This is similar to what happens when you drink from a straw. Though we say we are "sucking" liquid up through the straw, we really aren't. Outside air pressure is pushing down on the surface of the liquid. When you reduce the pressure in your mouth (that sucking action) the outside pressure is greater than the pressure inside your mouth and the soda shoots through the straw and into our mouths. The same thing is true with the can. The force applied downward into the cold water pushes the water up into the can. To put it simply, science doesn't suck... it just pushes and pulls.

More to do and some questions to ask your students:

Did the aluminum can change? Its shape changed but not its chemical make-up. It's still aluminum. The can being crushed is a physical change.

When matter changes states, it is a physical change. Physical changes happen when energy is added or taken away or when a force acts upon it to change its shape. What force changed the shape of the can?

What else could you do to the aluminum can to change it? Would it be a physical or chemical change?

Do the next demonstration to explore chemical changes.

Can Crusher demonstration retrieved from: <http://www.stevespanglerscience.com/experiment/00000043>

Demonstration 6: Dancing Raisins

Some things to wonder about before starting the activity:

What is a physical change?

What is a chemical change?

What state of matter are the ingredients?

You will mix two ingredients together.

Make predictions about what you think will happen when you mix vinegar and baking soda.

Make predictions about what you think will happen when you put the raisins in.

What you need for this activity:

- Tall clear glasses or cups
- Clear vinegar 3 Tbsp.
- Water to fill the glass 3/4 full
- Baking soda 2 tsp.
- Raisins (3-4 per glass)

What to do:

1. Fill each glass 3/4 full with water.
2. Mix in 2 tsp. of baking soda in water until dissolved.
3. Predict what will happen when you add the 3 Tbsp of vinegar all at once.
2. Add the vinegar.
3. Add the raisins.

What's happening:

A chemical reaction happens at a molecular level. In this reaction, molecular structures changed and became new chemicals. Very simply, the baking soda (solid) reacted with the vinegar (liquid) and made carbon dioxide (CO₂ gas) which then gathered on the surface area of the raisins and caused them to be less dense than the solution and rise and fall as CO₂ bubbles form and pop.

More to do and some questions to ask your students:

Do the Experiment 1: Balloon Blow up in the Museum-on-the-go Air Program Teacher Guide.

http://0101.nccdn.net/1_5/0dd/018/0fd/MOGTeacherGuideAirProgram.pdf

See the attached "Advance Thinking Fountain" for more advanced information on the chemical reaction that is happening here. Can you locate any of the elements on the periodic table?

This reaction is called an endothermic reaction. It feels cold when it happens.

<http://chemistry.about.com/cs/generalchemistry/a/aa051903a.htm>

For a fantastic exothermic reaction, do the Elephant Toothpaste demonstration

<http://www.stevespanglerscience.com/experiment/elephants-toothpaste>

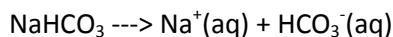
The Advanced Thinking Fountain

Describing the Chemical Reaction between Baking Soda and Vinegar

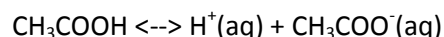
Baking soda, a pure chemical called sodium bicarbonate, has the chemical formula:



When dissolved in water, baking soda separates into sodium (Na^+) and bicarbonate ions (HCO_3^-):

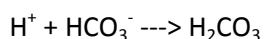


Vinegar, a weak (5%) solution of acetic acid in water, partially dissociates into hydrogen (H^+) and acetate ions (CH_3COO^-):

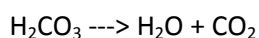


The reaction between baking soda and vinegar is actually two reactions, an acid base reaction followed by a decomposition reaction.

When the two ingredients are mixed, hydrogen ions (H^+) from the vinegar react with the bicarbonate ions (HCO_3^-) from the baking soda to form a new chemical called carbonic acid (H_2CO_3).

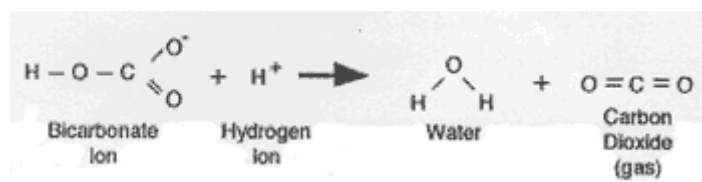


The carbonic acid thus formed then immediately decomposes into carbon dioxide gas (CO_2) and water (H_2O).

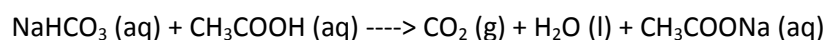


It's this carbon dioxide gas that you see bubbling and foaming as soon as you mix baking soda and vinegar together.

Using the molecular structures of only the components involved, the chemical reaction can be written:



The overall reaction however, is often written as follows:



info retrieved from: <http://www.apple-cider-vinegar-benefits.com/baking-soda-and-vinegar.html>

Additional resources:

For more outreach education check out the Sonoma County Water Agencies website and see if they can come to your school.

<http://www.scwa.ca.gov/education/>

Great websites for exploring the states of matter:

Basics about states of matter- Good visual before doing “**Demonstration 6: Molecule Dance.**” (teacher's guide page 15)

<http://www.chem.purdue.edu/gchelp/atoms/states.html>

Strange matter - Great site to explore about material science. We can't list just one activity. There are so many good ones with an incredible amount of content.

<http://strangematterexhibit.com/index.html>

Here's the link to their teacher guide. Recommended for grades 5-8.

http://strangematterexhibit.com/demoworks_final.pdf

Go to: page 14 to demonstrate how the atomic structure of a material can affect its properties.

page 15 to demonstrate different boiling points and how temperature effects a materials properties.

page 22 for another version of "Mix Without Stirring" (teacher's guide pg. 14)

Chemistry of matter - Good visuals and activity ideas.

http://www.chem4kids.com/files/matter_intro.html

Physical change - Changing from one state to another. From solid to liquid to solid again. It's still sugar, or CH₂OH. Demonstrates crystal formation and structure and seeding a supersaturation.

http://www.sciencebuddies.org/science-fair-projects/project_ideas/FoodSci_p005.shtml

Chemical change - For a fantastic exothermic reaction, do the Elephant Toothpaste demonstration

<http://www.stevespanglerscience.com/experiment/elephants-toothpaste>

Here are a couple of books about the states of matter that we found helpful in understanding and explaining matter:

K-3rd What Is the World Made Of? All About Solids, Liquids, and Gases (Let's-Read-and-Find-Out Science, Stage 2)
by: Kathleen Weidner Zoehfeld and Paul Meisel
ISBN-13: 978-0064451635

4th-6th States of Matter (Chemicals in Action (2nd Edition)
by : Chris Oxlade
ISBN-13: 978-1432900625.

CALIFORNIA CONTENT STANDARDS FOR DEMONSTRATIONS

***Demonstration 1- States of Matter Scavenger Hunt**

Grade K

Physical Sciences:

1. Properties of materials can be observed, measured, and predicted. AS a basis for understanding this concept.
 - 1a. Students know objects can be described in terms of the materials they are made of (e.g., clay, cloth, paper) and their physical properties (e.g., color, size, shape, weight, texture, flexibility, attraction to magnets, floating, sinking).
 - 1b. Students know water can be a liquid or a solid and can be made to change back and forth from one form to the other.

Investigation and Experimentation:

4. Scientific Progress is made by asking meaningful questions and conducting careful investigations. AS a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations.
 - 4a. Observe common objects by using the five senses.
 - 4b. Describe the properties of common objects.
 - 4d. Compare and sort common objects by one physical attribute (e.g., color, shape, texture, size, weight).

Grade 1

Physical Sciences:

1. Materials come in different forms (states), including solids, liquids, and gases. AS a basis for understanding this concept
 - 1a. Students know solids, liquids, and gases have different properties.

***Demonstration 2- Melting Ice Cubes and Disappearing Paint**

Grade K

Physical Sciences:

1. Properties of materials can be observed, measured, and predicted. AS a basis for understanding this concept.
 - 1a. Students know objects can be described in terms of the materials they are made of (e.g., clay, cloth, paper) and their physical properties (e.g., color, size, shape, weight, texture, flexibility, attraction to magnets, floating, sinking).
 - 1b. Students know water can be a liquid or a solid and can be made to change back and forth from one form to the other.

Investigation and Experimentation:

- 4b. Describe the properties of common objects.

Grade 1

Physical Sciences:

1. Materials come in different forms (states), including solids, liquids, and gases. AS a basis for understanding this concept
 - 1a. Students know solids, liquids, and gases have different properties.
 - 1b. Students know the properties of substances can change when the substances are mixed, cooled, or heated.

Earth Sciences:

- 3c. Students know the sun warms the land, air, and water.

Grade 3

Physical Sciences:

1. Energy and matter have multiple forms and can be changed from one form to another.
 - 1e. Students know matter has three forms: solid, liquid, and gas.
 - 1f. Students know evaporation and melting are changes that occur when the objects are heated.

Grade 5

Physical Sciences:

1. Elements and their combinations account for all the varied types of matter in the world.
 - 1b. Students know all matter is made of atoms, which may combine to form molecules.

***Demonstration 3: Will it Dissolve?**

Grade K

Physical Sciences:

1. Properties of materials can be observed, measured, and predicted. AS a basis for understanding this concept.
 - 1a. Students know objects can be described in terms of the materials they are made of (e.g., clay, cloth, paper) and their physical properties (e.g., color, size, shape, weight, texture, flexibility, attraction to magnets, floating, sinking).
 - 1b. Students know water can be a liquid or a solid and can be made to change back and forth from one form to the other.

Grade 1

Physical Sciences:

1. Materials come in different forms (states), including solids, liquids, and gases. AS a basis for understanding this concept
 - 1a. Students know solids, liquids, and gases have different properties.
 - 1b. Students know the properties of substances can change when the substances are mixed, cooled, or heated.

Grade 2

Investigation and Experimentation:

- 4b. Measure length, weight, temperature, and liquid volume with appropriate tools and express those measurements in standard metric system units

Grade 3

Physical Sciences:

- 1f. Students know evaporation and melting are changes that occur when the objects are heated.

Grade 5

Physical Sciences:

1. Elements and their combinations account for all varied types of matter in the world.
 - 1g. Students know properties of solid, liquid, and gaseous substances, such as sugar (C 6 H 12 O 6), water (H 2 O), helium (He), Oxygen (O 2), nitrogen (N 2), and carbon dioxide (CO 2).

***Demonstration 4- Liquid Layers**

Grade K

Physical Sciences:

1. Properties of materials can be observed, measured, and predicted. AS a basis for understanding this concept.
 - 1a. Students know objects can be described in terms of the materials they are made of (e.g., clay, cloth, paper) and their physical properties (e.g., color, size, shape, weight, texture, flexibility, attraction to magnets, floating, sinking).

Investigation and Experimentation:

- 4d. Compare and sort common objects by one physical attribute (e.g., color, shape, texture, size, weight).

Grade 1

Physical Sciences:

1. Materials come in different forms (states), including solids, liquids, and gases. AS a basis for understanding this concept
 - 1a. Students know solids, liquids, and gases have different properties.
 - 1b. Students know the properties of substances can change when the substances are mixed, cooled, or heated.

Grade 2

Investigation and Experimentation:

- 4b. Measure length, weight, temperature, and liquid volume with appropriate tools and express those measurements in standard metric system units.
- 4c. Compare and sort common objects according to two or more physical attributes (e.g., color, shape, texture, size, weight).

Grade 5

Physical Sciences:

- 1f. Students know differences in chemical and physical properties of substances are used to separate mixtures and identify compounds.

***Demonstration 5- Mix Without Stirring**

Grade K

Physical Sciences:

1. Properties of materials can be observed, measured, and predicted. AS a basis for understanding this concept.

1a. Students know objects can be described in terms of the materials they are made of (e.g., clay, cloth, paper) and their physical properties (e.g., color, size, shape, weight, texture, flexibility, attraction to magnets, floating, sinking).

1b. Students know water can be a liquid or a solid and can be made to change back and forth from one form to the other.

Grade 1

Physical Sciences:

1. Materials come in different forms (states), including solids, liquids, and gases. AS a basis for understanding this concept

1a. Students know solids, liquids, and gases have different properties.

1b. Students know the properties of substances can change when the substances are mixed, cooled, or heated.

Grade 2

Investigation and Experimentation:

4b. Measure length, weight, temperature, and liquid volume with appropriate tools and express those measurements in standard metric system units

Grade 3

Physical Sciences:

1f. Students know evaporation and melting are changes that occur when the objects are heated.

Grade 5

Physical Sciences:

1. Elements and their combinations account for all varied types of matter in the world.

1g. Students know properties of solid, liquid, and gaseous substances, such as sugar (C 6 H 12 O 6), water (H 2 O), helium (He), Oxygen (O 2), nitrogen (N 2), and carbon dioxide (CO 2).

***Demonstration 6- Molecule Dance**

Grade 3

Physical Sciences:

1. Energy and matter have multiple forms and can be changed from one form to another.

1e. Students know matter has three forms: solid, liquid, and gas.

1f. Students know evaporation and melting are changes that occur when the objects are heated.

1h. Students know all matter is made of small particles called atoms, too small to see with the naked eye.

Grade 5

Physical Sciences:

1a. Students know that during chemical reactions the atoms in the reactants rearrange to form products with different properties.

1b. Students know all matter is made of atoms, which may combine to form molecules.

Earth Sciences:

3b. Students know when liquid water evaporates, it turns into water vapor in the air and can reappear as a liquid when cooled or as a solid if cooled below the freezing point of water.

***Demonstration #7- Can Crusher (Physical Change)**

Grade K

Physical Sciences:

1a. Students know objects can be described in terms of the materials they are made of (e.g., clay, cloth, paper) and their physical properties (e.g., color, size, shape, weight, texture, flexibility, attraction to magnets, floating, sinking).

1b. Students know water can be a liquid or a solid and can be made to change back and forth from one form to the other.

Investigation and Experimentation:

4d. Compare and sort common objects by one physical attribute (e.g., color, shape, texture, size, weight).

Grade 1

Physical Sciences:

1. Materials come in different forms (states), including solids, liquids, and gases. As a basis for understanding this concept

1a. Students know solids, liquids, and gases have different properties.

Grade 2

Investigation and Experimentation:

4c. Compare and sort common objects according to two or more physical attributes (e.g., color, shape, texture, size, weight).

Grade 3**Physical Sciences:**

1e. Students know matter has three forms: solid, liquid, and gas.

1f. Students know evaporation and melting are changes that occur when the objects are heated.

Grade 5**Earth Sciences:**

3b. Students know when liquid water evaporates, it turns into water vapor in the air and can reappear as a liquid when cooled or as a solid if cooled below the freezing point of water.

Demonstration #8- Dancing Raisins*Grade 3****Physical Sciences:**

1. Energy and matter have multiple forms and can be changed from one form to another.

1e. Students know matter has three forms: solid, liquid, and gas.

1h. Students know all matter is made of small particles called atoms, too small to see with the naked eye.

Grade 5**Physical Sciences:**

1a. Students know that during chemical reactions the atoms in the reactants rearrange to form products with different properties.

1b. Students know all matter is made of atoms, which may combine to form molecules.

1f. Students know differences in chemical and physical properties of substances are used to separate mixtures and identify compounds.