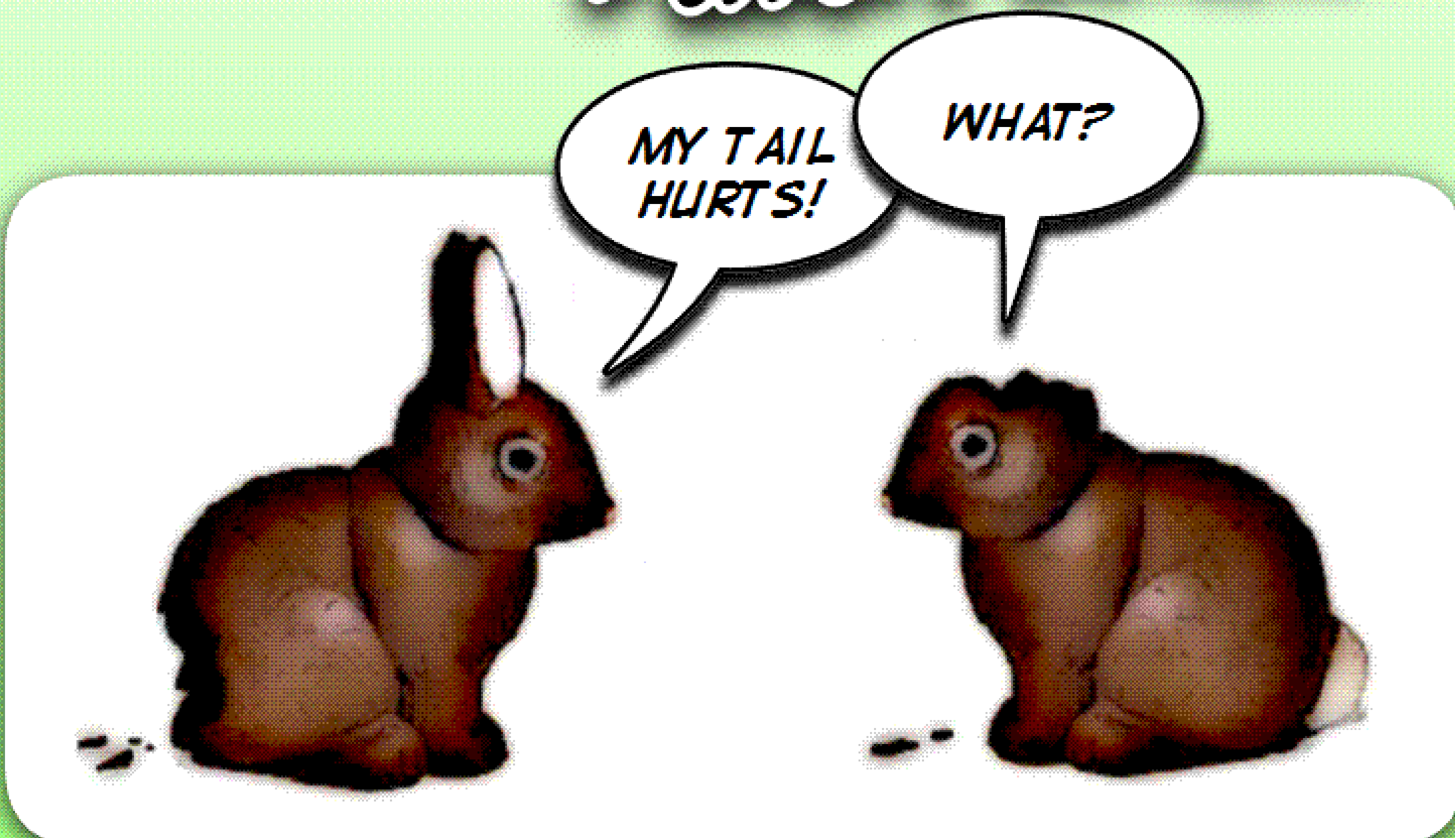
The Science of Food:

Dessert Edition



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TO INSPIRE SCIENTIFIC CURIOSITY AND LEARNING FOR A BETTER COMMUNITY

Chocolate Lava Cakes

Students will explore many Earth science concepts with this dessert.

Materials:

Four (4) 6 oz. ramekins
5 Tbs Butter (plus a little more to grease the ramekins)
4 oz Bittersweet chocolate (Ghirardelli)
1 oz Unsweetened chocolate (Ghirardelli)
$\frac{3}{4}$ cup Sugar (plus a little more to dust the ramekins)
1 Tbs Cornstarch
2 Eggs plus one extra yolk (room temperature)

Activity:

Melt the butter and both chocolates in a glass bowl in a microwave. (Do not heat for more than 30 second intervals!)
Add the sugar, cornstarch, two whole eggs and one yolk to the mixture and mix.
Grease each ramekin with a small amount of butter and dust with a little sugar.
Scoop $\frac{1}{2}$ cup of the mixture into each ramekin.
Bake at 375° for 16-20 minutes (until the tops begin to crack)

Explanation:

A lot of science is at work in this recipe:

- **Radiation** of the oven causes the insides of the oven, and the ramekins, to heat up.
- **Conduction** of the heat from the ramekins into the mixture causes it to heat up.
- **Convection** of heated air from the heating coils in the oven can be demonstrated.
- **Weathering** on the surface of the cakes from the excessive heat and lack of moisture causes them to crack.
- **Chemical change** of the mixture from a **liquid** into a **solid** takes place with the addition of **heat energy**.
- The surface of the cake represents the hardened **crust** of the Earth while the moist, semi-solid center represents the **mantle**.
- The hardening of the cake as it cools represents the formation of **igneous rocks** as they are formed from the rapid cooling of **magma**.

Chemical Pie

Students will enjoy an apple pie without the use of apples in the recipe.

Materials:

Pastry for two pie crusts (top and bottom)
Box of crackers
½ cup Sugar
1 tsp Butter
Cinnamon
½ tsp Cream of tartar
Pie pan
Large pot

Activity:

1. Place 2 cups of water in the pot and heat it until it boils.
2. While the water is heating, mix the sugar and cream of tartar in a bowl.
3. Add the mixture to the boiling water, a little at a time and stir to dissolve completely.
4. Add 20-25 whole crackers, one at a time, to the boiling solution.
5. Boil for about 3 minutes, but do not stir.
6. Pour the mixture into a pastry-lined pie pan.
7. Sprinkle a small amount of cinnamon on top of the pie filling.
8. Melt the butter and drip it evenly over the filling.
9. Cover with a pastry top, Stick a knife through the top several times to allow steam to escape.
10. Bake the pie in a preheated oven at 450 degrees F for about 20 minutes or until the curst is brown.
11. Cool, and enjoy eating your experiment.

Explanation:

The cream of tartar produces a weak acid, which combines with other ingredients to produce the tangy taste of apples. The acid, combined with the pieces of solid cracker, closely resembles the taste and appearance of apple pie. It tastes like apple pie and look like apple pie because our senses will be tricked into thinking that it is apple pie. Because our senses are easily tricked, as scientists we must use sensitive instruments to measure changes that occur around us.

Liquid Nitrogen Ice Cream

Homemade ice cream in 30 seconds!

Materials:

3 cups Half and half
2 cups Whole milk
½ cup Sugar
1 Tbs Vanilla
Metal bowl
Wooden spoon
1-2 liters Liquid nitrogen

Activity:

1. Mix the ingredients until the sugar has dissolved into the milk and cream.
2. Pour in the Liquid nitrogen *slowly* and mix with the wooden spoon until completely frozen, which should be about 30-60 seconds. Wear the gloves, because it's going to be cold.

Explanation:

The liquid nitrogen absorbed the heat from the blended mixture. As this happened, the liquid nitrogen boiled off taking the heat into the atmosphere and away from the cream! Remember...liquid nitrogen boils at -195 degrees Celsius (and room temperature is normally around 25 degrees Celsius!!!)

Liquid Nitrogen Safety Notes & Concerns

Liquid nitrogen is a dangerous material. The following is an excerpt from the Air Products Nitrogen Material Safety Data Sheet:

> *The entire contents of a 10 Liter Dewar being spilled in an unventilated 274 square foot room with an 8 foot ceiling would reduce oxygen levels below the 19.5% level where Air Products recommends the use of a respirator. Since many rooms are larger than this, suffocation does not represent a major danger. When transporting the liquid in a car, however, it is probably a good idea to open a window.*

The possibility of freeze burns represents a much more serious danger and is therefore our first concern. This does not mean that the demonstration itself is dangerous, but it does mean **you must be careful**. Dangers include:

Nitrogen can spatter (possibly in eyes) while being poured.

Flying chunks of frozen objects could cause eye injury.

Children (being curious) will want to reach out and touch nitrogen or other cold objects. As mentioned above, contact with nitrogen can cause tissue damage, and this must be prevented.

Therefore specific safety precautions should include:

Stress to children the importance of not touching frozen objects or nitrogen.

Wear goggles whenever pouring or dumping nitrogen.

Nitrogen can spatter into the eyes, and potentially blinding pieces of frozen things can fly around when we drop it.

Use a glove and / or tongs to handle any object going into or out of nitrogen and to carry the nitrogen Dewar.

Adults should familiarize themselves with the following first aid instructions (excerpted from the Air Products Nitrogen Material Safety Data Sheet) for cryogenic freeze burns just in case the worst happens:

If cryogenic liquid or cold boil off contacts a worker's skin or eyes, frozen tissues should be flooded or soaked with tepid water (105-115F, 41- 46C). **DO NOT USE HOT WATER**. Cryogenic burns which result in blistering or deeper tissue freezing should be seen promptly by a physician. Remember to stress the importance of not touching liquid nitrogen or frozen objects.

THE IN'S AND OUT'S OF LIQUID NITROGEN

First of all...liquid nitrogen is not a toy! Be certain to read the safety precautions prior to its use and never never never allow children to play with this!!! With that being said, Here's the details...

Nitrogen is the major component of our air (79%). Even though nitrogen is a gas at room temperature, it is possible to contain it as a liquid if its temperature can be reduced to -196°C. Any object (solid, liquid or gas) that comes in contact with liquid nitrogen that is above this temperature will cause it to boil!!!

Liquid nitrogen is stored in a Dewar flask which is like a well-insulated thermos bottle. Never use a thermos bottle to store liquid nitrogen! The Dewar allows the nitrogen gas to escape. If the gas is not allowed a chance to escape, it can cause the flask to explode!!

Where do you get liquid nitrogen? You may try the following sources:

- A local college or university. Make a contact with their chemistry department. This may prove used for many other things and ideas as well.
- A high school in the area may have a Dewar flask which you can share.
- Local industry such as oil companies, welders or welding suppliers, food companies, meat packers that use freeze drying, frozen food processors or distributors, research labs, steel or metal processing companies, air products companies, airports, etc...
-

Be safe...wear goggles and gloves at all times...respect the nitrogen!!!

Ice cream in a Baggie

Okay...okay! Some of you may not have access to liquid nitrogen. I understand! But with the cold weather coming our way, I would guess that many of you have some rock salt around your home! With a little rock salt and a couple of sealable baggies, you can make your own ice cream at home! Here's what you need:

Materials:

½ Whole milk
½ cup Half and half
¼ cup Sugar
¼ tsp Vanilla
One gallon-sized and quart-sized sealable baggie
2 cups of ice
½ - ¾ cup of Rock salt

Activity:

1. Pour all of the ingredients except for the ice and salt into the quart-sized baggie. Seal it up and mix well!
2. Place the ice and rock salt into the gallon-sized baggie.
3. Now place the sealed baggie with your cream mixture into the larger baggie and seal it up!!!
4. Gently rock the back from side to side for about 10 minutes. You may want to cover the bag in a towel if your hands get too cold!
5. Open the gallon bag to remove the smaller baggie when the blended mixture has solidified into ice cream!

Explanation:

Ice has to absorb energy in order to melt. When you use ice to cool the ingredients for ice cream, the energy is absorbed from the ingredients and from the outside environment (like your hands!!!)
When you add salt to the ice, it lowers the freezing point of the ice, so even more energy has to be absorbed from the environment in order for the ice to melt. This makes the ice colder than it was before which is how your ice cream freezes!

Metamorphic Snickers

Students will explore the creation of metamorphic rocks with the use of a Snickers candy bar.

Materials:

Snickers bar
Two pieces of wood about 1 foot square
Knife

Activity:

1. Cut the Snicker's bar in half CLEANLY and have the student diagram the layers. This represents the layers of rock at some place in the surface, say right under his feet.
2. Now, place ONE half between the two boards and have a child stand or jump on it! They seem to like this approach better.
3. Now, take the smooshed Snicker's bar, cleanly cut it in half, and have the kid re-sketch the "new" layers. Note the previous layers are no longer recognizable and it seems that only one layer exists.

Explanation:

A metamorphic rock is a rock that has been created from extreme heat and/or pressure under the Earth. At the beginning of this activity, students should be able to easily recognize the different layers within the cross section of the candy bar. After a huge amount of pressure is exerted on the candy, however, these layers are very difficult, if not impossible, to determine. This is similar to the action of the Earth as it “squeezes” an igneous or sedimentary rock into a metamorphic rock.

Snickers Tectonics

The student will be able to define what plate tectonics and faults are.

Materials:

Snickers/Milky Way candy bars (1/student, slightly warm or at room temp)
Clean scrap paper (for the Snickers Earthquake) or other clean surface

Activity:

1. Pass out candy bars to students (students should wash their hands prior to this activity). Tell students that they are going to use candy bars to simulate the three types of faults to see what happens to the Earth when this movement occurs. In order to do this, tell students that they will have to imagine that their candy bar is the Earth. Using their fingernails, they should make a few breaks in the Earth's crust, or the top of the candy bar.
2. To illustrate **normal faults**, have students gently pull on edges of the candy bar. They will notice that the plates move apart to reveal the caramel/nuts, or the Earth's mantle. Record students' observations on the board.
3. To illustrate the force of **transform faults**, have the students push the pieces of chocolate, or plates, back together then slide one half of the candy bar forward and the other piece backwards. Record students' observations on the board.
4. To illustrate **thrust faults**, have the students push on both ends of the candy bar to squeeze it together. They should notice the plates colliding and possibly see one slide over the top of another. Record observations.

Explanation:

The Earth is made up of interlocking pieces of land called *tectonic plates* (tectonic plates can be illustrated by showing students the peels of an orange—the peel is the Earth's crust, the pieces of peel the plates). These plates are constantly in motion. When plates collide or separate, the results can be earthquakes, the creation of mountains, and volcanic activity. Plates come into contact at places called *faults*. There are three types of faults:

Normal faults are distinguished by fault blocks that slide in such a way that one block is down-dropped (lowered) relative to the other block. This happens when the crust extends, or stretches. The Basin and Range in the western United States is a geographic province dominated by normal faults. It encompasses all of Nevada and portions of surrounding states. The Basin and Range is a region with rows of mountains and valleys trending north and south formed by normal faults.

Thrust faults- are distinguished by a package of rock (fault block) that pushes up and over another rock pack-age resulting in crustal thickening. This fault movement happens when plates collide or push together, such as regions where one plate is being subducted under another as in Japan.

Transform faults (also called strike-slip faults) are distinguished by side to side sliding of fault blocks. Think of a transform fault as two cars, moving in opposite directions, passing on the road. A well known example of a trans-form fault is the San Andreas Fault in California. They occur where ever the crust is being stretched or pulled in opposite directions.

How to keep your soda from exploding...

Demonstrates the expansion of gas when pressure decreases.

Materials:

Two 20 oz. plastic bottles of soda, preferably a clear soda, such as sprite or 7-up. A back yard. A parent. A bathtub(to clean up.)

Activity:

1. NEVER point a soda bottle towards yourself or another person when opening it. Don't shake it too much.
2. Go to your backyard, BEFORE taking a bath. Grab a parent. Grab a bottle of soda. Shake it up.
3. Open it immediately, but first, make sure it isn't pointing at anyone. Presto! Fizz all over the place!
4. Grab the other bottle of soda. Shake it up. Tap on the sides so that there aren't any bubbles sticking to them. Make sure there aren't any bubbles beneath the surface of the pop. Now open this one. This time, there shouldn't be much fizz.

Explanation:

Before you opened the first bottle of soda, there were lots of little bubbles floating around in it. There was also a lot of pressure inside the bottle. Gas expands when you release pressure from it. All of those little bubbles expanded and overfilled the bottle. When you opened the second bottle of soda, there weren't any big bubbles in the soda. Therefore, the only gas that could expand was the gas on top of the soda. Since this is not beneath the soda, it couldn't carry any pop out of the bottle. The fizz that you did see was from bubbles that were too tiny to see before you opened it. The bath dissolved all of the sticky soda off of you.

How much sugar is found in soda?

Ever bother to look at the back of a soda can? Maybe you've seen that a regular can of soda — 12 ounces — has about 150 calories. And that's where most people stop reading. There's no fat, and hardly any sodium. Nothing to see here. But there is some sugar. 40 grams.

Ok. 40 grams. That's not a really big number. Some people just like sweet drinks. There's people who order a small coffee — McDonalds serves a 12 ounce small coffee — and they put 5 or 6 sugar packets in it. Maybe they use sugar cubes. 1 sugar packet = 1 sugar cube. So how much sugar is in a packet, or cube? Not **every** sugar packet is the same size, but almost all of the sugar packets you'll see in the United States contain 4 grams of sugar. And those 4 grams of sugar have 15 calories.

That means there are 10 packets of sugar in a can of soda. And at 15 calories per packet, that means that all 150 calories are from the sugar.

"But I buy bottled soda"

So how much sugar is in a bottle of soda? Well, most bottles of soda are 20 ounces. 20 ounces has 69 grams, divide by 4, and it means there's 17-and-one-quarter sugar packets in a 20 oz soda bottle. A medium soda cup from McDonalds holds 21 ounces.

So what?

Well, for one thing: if you're at risk for diabetes, lots of sugar doesn't help you at all. You probably know that when the body digests sugar, your pancreas releases insulin to help you use the sugar energy. Too much sugar and you can wear out your pancreas.

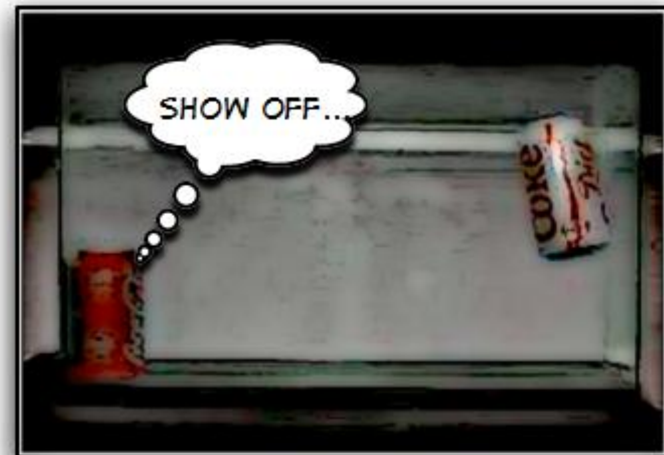
Not to mention that sugar makes you fat. How fat? Well, let's pretend that you consume the exact number of calories needed to power your body, every single day, and no more. That's a pretty good diet. Now, to reward yourself, you enjoy a soda every day. Just one, you don't want to go overboard.

That one soda per day adds 150 calories every day. 150 calories * 365 days equals 54,750 calories each year. Since there's 3500 calories per pound, that one soda per day adds 15.64 pounds per year. If you weren't already fat, you will be soon.

Floating Soda

Students will explore the concept of density using soda cans.

Materials:



12 oz Coke can
12 oz Diet coke can
Water
Fish tank or large bucket
Sugar
Nutra sweet

Activity:

1. Pass the cans of coke around the room. Have each student take a good look at each can and ask them to make careful observations about what they see.
2. Ask the students to name as many similarities as they can about the 2 cans of coke. Make a list on the board.
3. Ask the students to list as many differences as they can about the 2 cans.

<u>Some answers they may come up with......</u>

Similarities	Differences
are made by the same company	one is red, the other is silver
have the same shape	one is diet, one is regular
made of aluminum	one has nutra sweet
are sealed shut	etc...
have the same amount of liquid	
similar weights	
contain water	
contain carbon dioxide	
both have caffeine	
etc...	

4. Place the regular coke into a small tank of water.
5. Place the diet coke into the water. (Look surprised and take both out. Have a student come up to verify that the cans are still sealed and have not been tampered in anyway!)
6. Place back into water. Ask the students to explain why one is floating.

<u>Possible responses…</u>

They weren't filled right at the plant

The red paint is heavier than the silver paint, or vice versa

One is flat, the carbon dioxide must have leaked out

Nutra sweet is lighter than sugar

etc.....

Explanation:

Show the students what 39 g of sugar looks like (I found it effective to show the sugar in a small beaker while holding it next to the can so they can see how much space it would take up in the can) next to approximately 188 mg (on an index card) of Nutra Sweet. Explain that ALL that sugar is in the regular Coke can, and that small amount of Aspartame in the Diet Coke can. Explain that a small amount of Aspartame is needed to make the Diet Coke sweet because it is so concentrated. Most students are surprised to actually see how much sugar there is!

Discuss how more "stuff" (matter) is crammed into the same amount of space, or volume, and that increases the mass. The relationship of mass to volume is density. The more items (matter) you place into a defined space, the denser it becomes. For example, New York City is densely populated because there are a lot of people in a small area. 20 people in an elevator is denser than 2 people in an elevator.

The density of water is $1g/cm^3$. An object will float is the density is less than 1. An object will sink if its density is greater than 1.

*Note: According to the Coca Cola company : 8 oz can has (125 mg) of aspartame . A can has 12 oz, so I approximated 188 mg for measuring purposes since my triple beam balance has a 0.1g bar. You can also say that there are 39,000 milligrams of sugar in a can of regular Coke!!!

Rock Hard Bug Candy (Amber)

I hope the title says it all...

Materials:

Karo syrup
Sugar
Pan
Muffin tin
Pam
Bugs
Molasses
Measuring cup

Activity:

1. Combine 1 part Karo, 2 parts sugar, 1 part water, and 5 drops molasses in a sauce pan.
2. Heat on high till it reaches the "cracking point" (i.e. place a drop of the heated mixture in a glass of cold water. If it instantly turns to a nice solid ball, you have reached the cracking point. This usually takes about 10 minutes of boiling time).
3. Spray muffin tin with Pam or some other non-stick substance (i.e. butter, Crisco, etc.). Place bugs in muffin tin and pour in "amber" mixture. Let cool until mixture becomes solid (at least 20 minutes).
4. Carefully flip the muffin tin onto a towel or cloth to avoid breaking the amber fossils.
5. These amber fossils are edible, but I do not recommend eating the bugs.

Explanation:

Amber is a fossilized resin formed from coniferous trees. It is usually yellow, orange, red or brown; and transparent when not oxidized. Amber has the ability to entrap and enclose insects and other organisms and preserve them for millions of years. ...

Jello Heart

Create your own model of a heart using a pre-made heart mold.

Materials:

One large, 6 ounce box of peach or watermelon flavored gelatin. (Use any flavor, if a flesh tone is not desired)
Six oz Lite evaporated skimmed milk (99.5% fat free)
Oil cooking spray (to lubricate the plastic mold)
Green food coloring
One cup boiling water

Activity:

1. Spray a small amount of cooking oil inside of the cavity of the plastic mold.
2. Place gelatin from the boxes into a large bowl.
3. Add 1 cup of boiling water. Stir gelatin with a whisk until it is completely dissolved, about 3 minutes.
4. Add skimmed milk and stir for one minute.
5. Add a few drops of green food coloring to produce the flesh tone color, re-stir.
6. Pour gelatin mixture into the plastic Heart mold.
7. Fashion a towel inside of a rectangular cake pan. Set the Heart mold inside and level. This will keep the mold level.
8. Place the mold in the refrigerator overnight.

   Extracting the hardened gelatin from the mold:
9. Put on a cooking glove, and carefully loosen the gelatin away from the wall of the mold.
10. Place the open palm of your gloved hand on the top of the gelatin, and turn the mold over.
11. Use a slight grabbing or pulling motion to pull the gelatin out of the mold.
12. Use the tip of a potato peeler to cut a hole into the large artery, to make it look more realistic. Repeat this for the other two, smaller arteries. You may need a small paring knife for the smaller arteries.
13. Place mold onto a plate or a platter.
14. Use a butter knife to trim away any excess gelatin.
15. Cover the mold with a plastic food wrap and return the mold to the refrigerator until you are ready to put it on display and serve it.

The Science of PopRocks

Dissolved carbon dioxide gas effects the acidity of tap water.

Materials:

Eye protection
Dropping bottles of: vinegar, tap water, bromothymol blue indicator, and baking soda solution (teaspoon of baking soda dissolved in a cup of tap water)
Petri dish
Quarter of a package of Pop Rocks
Spot plate
Stirring rod

Activity:

1. Put on eye protection.
2. Add 5 drops of vinegar (a mild acid) to one well of the spot plate.
3. Add 5 drops of the baking soda solution (a mild base) to another well.
4. Add 5 drops of tap water (approx. neutral) to a third well.
5. Add two drops of bromothymol blue indicator to each of the three wells. Note any color changes that occur.
6. Half-fill a Petrie dish with tap water.
7. Add 5-10 drops of bromothymol blue indicator to the dish and swirl until the color of the mixture is uniform.
8. Record the color of the mixture.
9. Sprinkle a quarter of a package of Pop Rocks (about 0.5 g) into the dish. Stir the dish to mix its contents.
10. Record the color of the mixture.

Explanation:

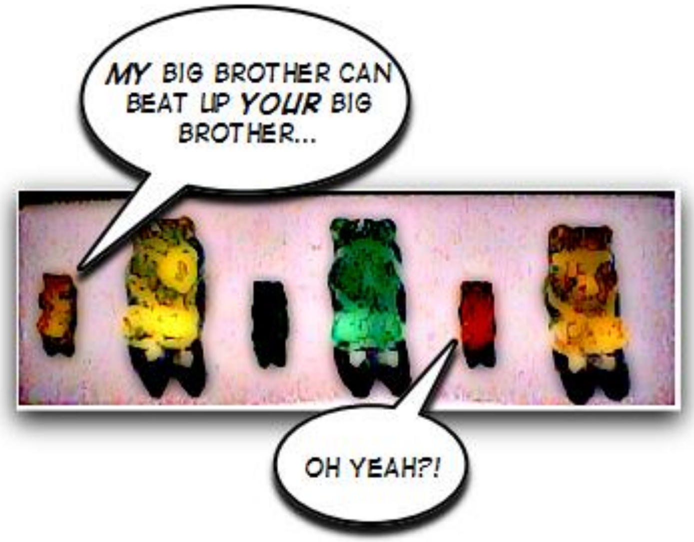
Carbon dioxide is one of a number of gases that can alter the acidity of water. Because carbon dioxide is such a common gas, it is important to understand the effect that dissolved carbon dioxide has on the acidity of water. In this investigation, you will dissolve carbon dioxide into water and observe its effect on water's acidity using an acid/base indicator. However, the source of carbon dioxide you will use is rather unusual. Pop Rocks are a type of candy that, as their name suggests, "pop" in your mouth as they dissolve. When Pop Rocks are made tiny bubbles of pressurized carbon dioxide gas are trapped within each kernel. As the candy dissolves in your mouth, the pressurized carbon dioxide is released with a resounding POP!

Gummy bear diffusion

Students will investigate the movement of water into and out of a polymer.

Materials:

2 Drinking glasses
Permanent marker
2 Gummy Bears (different colors)
Distilled water
Saturated salt solution (6 oz per cup)
Water



Activity:

1. On the side of each cup, write your name and class period using a permanent marker.
2. Label one cup "TAP WATER" and the other "DISTILLED WATER".
3. Place the bears in the cups and cover one with distilled and one with tap water.
4. Have the students complete a hypothesis:

   If someone places Gummy Bears in tap water, then the size of the bears will (increase, decrease, remain the same). Circle your answer.

5. Place the cups on the counter away from direct sunlight. Let them sit overnight.
6. On the next lab day, gently pour the water out and gently place the bear on the table.
7. Place the bears back into their correct cups. Cover the bears with saturated salt solution. Let them sit overnight.
8. Have the students complete a hypothesis:

   If someone places Gummy Bears in salt water, then the size of the bears will (increase, decrease, remain the same). Circle your answer.

Explanation:

Gummy Bears are made of gelatin and sugar. Gelatin is a polymer that forms large three-dimensional matrices which give structural support to jellies and jams, and lots of other things that you use every day.

The bears will grow to several times their original size when placed in distilled water for twenty-four hours. They will also shrink back to their original size if they are placed in saturated salt solution. This is because the high concentration of distilled water will diffuse through the gelatin of the bears since there is a low concentration of water naturally in them. When these water-soaked bears are placed into a container of saturated salt water solution, there is a higher concentration of water inside the bear than in the surrounding water. Therefore, the high concentration of water inside the bear will diffuse outward!