Colourful density column:

You don't have to use lots of different chemicals to make a colourful density column. This project uses coloured sugar solutions made at different concentrations. The solutions will form layers, from least dense, on top, to most dense (concentrated) at the bottom of the glass.

Here's How:

1. Line up five glasses. Add 1 tablespoon (15 g) of sugar to the first glass, 2 tablespoons (30 g) of sugar to the second glass, 3 tablespoons of sugar (45 g) to the third glass, and 4 tablespoons of sugar (60 g) to the fourth glass. The fifth glass remains empty.
2. Add 3 tablespoons (45 ml) of water to each of the first 4 glasses. Stir each solution. If the sugar does not dissolve in any of the four glasses, then add one more tablespoon (15 ml) of water to each of the four glasses.
3. Add 2-3 drops of red food colouring to the first glass, yellow food colouring to the second glass, green food colouring to the third glass, and blue food colouring to the fourth glass. Stir each solution.
4. Now let's make a rainbow using the different density solutions. Fill the last glass about one-fourth full of the blue sugar solution.
5. Carefully layer some green sugar solution above the blue liquid. Do this by putting a spoon in the glass, just above the blue layer, and pouring the green solution slowly over the back of the spoon. If you do this right, you won't disturb the blue solution much at all. Add green solution until the glass is about half full.
6. Now layer the yellow solution above the green liquid, using the back of the spoon. Fill the glass to three-quarters full.
7. Finally, layer the red solution above the yellow liquid. Fill the glass the rest of the way.

Tips:

1. The sugar solutions are miscible, or mixable, so the colours will bleed into each other and eventually mix.
2. If you stir the rainbow, what will happen? Because this density column is made with different concentrations of the same chemical (sugar or sucrose), stirring would mix the solution. It would not un-mix, like you would see with oil and water.
3. Try to avoid using gel food colouring. It is difficult to mix the gels into the solution.

4. If your sugar won't dissolve, an alternative to adding more water is to microwave the solutions for about 30 seconds at a time until the sugar dissolves. If you heat the water, use care to avoid burns.
5. If you want to make layers you can drink, try substituting unsweetened soft drink mix for the food colouring, or four flavors of sweetened mix for the sugar plus colouring.
6. Let heated solutions cool before pouring them. You'll avoid burns, plus the liquid will thicken as it cools so the layers won't mix as easily.
7. Use a narrow container rather than a wide one to see the colours the best,

Rubber eggs

A Mad Scientist can make a toy out of just about anything, including a boiled egg. Soak an egg in a common kitchen ingredient, vinegar, to dissolve its shell and make the egg rubbery enough that you can bounce it on the floor like a ball. Soaking chicken bones in vinegar will soften them so that they will become rubbery and flexible.

Rubber Egg Materials

- hard-boiled egg
- glass or jar, big enough to hold the egg
- vinegar

Turn the Egg into a Bouncy Ball

1. Place the egg in the glass or jar.
2. Add enough vinegar to completely cover the egg. watch the egg. What do you see? Little bubbles may come off the egg as the acetic acid in the vinegar attacks the calcium carbonate of the eggshell. Over time the colour of the eggs may change as well.
3. After 3 days, remove the egg and gently rinse the shell off of the egg with tap water.
4. How does the boiled egg feel? Try bouncing the egg on a hard surface. How high can you bounce your egg?

5. You can soak raw eggs in vinegar for 3-4 days, with a slightly different result. The eggs shell will become soft and flexible. You can gently squeeze these eggs, but it's not a great plan to try to bounce them on the floor.

Magic Milk

If you add food colouring to milk, not a whole lot happens, but it only takes one simple ingredient to turn the milk into a swirling colour wheel. Here is what you do.

Magic Milk Materials

- 2% or whole milk
- food colouring
- dishwashing liquid
- cotton swab
- plate

Magic Milk Instructions

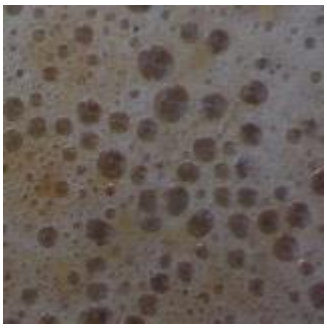
1. Pour enough milk onto a plate to cover the bottom.
2. Drop food colouring onto the milk.
3. Dip a cotton swab in dishwashing detergent liquid.
4. Touch the coated swab to the milk in the center of the plate.
5. Don't stir the milk; it isn't necessary. The colours will swirl on their own as soon as the detergent contacts the liquid.

How It Works

Milk consists of a lot of different types of molecules, including fat, protein, sugars, vitamins, and minerals. If you had just touched a clean cotton swab to the milk (try it!), not much would have happened. The cotton is absorbent, so you would have created a current in the milk, but you wouldn't have seen anything especially dramatic happen.

When you introduce detergent to the milk, several things happen at once. The detergent lowers the surface tension of the liquid so that the food colouring is free to flow throughout the milk. The detergent reacts with the protein in the milk, altering the shape of those molecules and setting them in motion. The reaction between the detergent and the fat forms micelles, which is how detergent helps to lift grease off of dirty dishes. As the micelles form, the pigments in the food colouring get pushed around. Eventually equilibrium is reached, but the swirling of the colours continues for quite a while before stopping.

Honeycomb Candy



- 3/4 cup sugar
- 2 tablespoons honey
- 2 tablespoons water
- 1-1/2 teaspoons baking soda

Honeycomb Candy Instructions

1. Grease a cookie sheet. You can use oil, butter, or non-stick cooking spray.
2. Add the sugar, honey, and water to a saucepan. You can stir the mixture, but it isn't necessary.
3. Cook the ingredients over high heat, without stirring, until the mixture reaches 300°F. The sugar will melt, small bubbles will form, the bubbles will become larger, then the sugar will start to caramelize to an amber colour.
4. When the temperature reaches 300°F, remove the pan from heat and whisk the baking soda into the hot syrup. This will cause the syrup to foam up.
5. Stir just enough to mix the ingredients, then dump the mixture onto the greased baking sheet. Don't spread out the candy, as this would pop your bubbles.
6. Allow the candy to cool, then break or cut it into pieces.
7. Store the honeycomb candy in an airtight container.

Honeycomb candy is an easy-to-make candy that has an interesting texture caused by carbon dioxide bubbles getting trapped within the candy. The carbon dioxide is produced when baking soda (sodium bicarbonate) is added to hot syrup. It is the same process used to make some baked goods rise, except here the bubbles are trapped to form a crisp candy. The holes in the candy make it light and give it a honeycomb appearance.

Make Rubbery Chicken Bones

If you soak chicken bones in vinegar (the thinner bones work best), the vinegar will react with the calcium in the bones and weaken them so that they will become soft and rubbery, as if they had come from a rubber chicken. It is the calcium in your bones that makes them hard and strong. As you age, you may deplete the calcium faster than you replace it. If too much calcium is lost from your bones, they may become brittle and susceptible to breaking. Exercising and eating a diet that includes calcium-rich foods can help prevent this from happening.

Egg in a Bottle Materials

- peeled hard-boiled egg (or soft-boiled, if a yolk mess interests you)
- flask or jar with opening slightly smaller than the diameter of the egg
- paper/lighter *or* very hot water *or* very cold liquid

If you use too large of an egg, it will get sucked into the bottle, but stuck (resulting in a gooey mess if the egg was soft-boiled) An extra-large egg gets wedged in the bottle.

Perform the Demonstration

- Method 1: Set a piece of paper on fire and drop it into the bottle. Set the egg on top of the bottle (small side pointed downward). When the flame goes out, the egg will get pushed into the bottle.
- Method 2: Set the egg on the bottle. Run the bottle under very hot tap water. Warmed air will escape around the egg. Set the bottle on the counter. As it cools, the egg will be pushed into the bottle.
- Method 3: Set the egg on the bottle. Immerse the bottle in a very cold liquid. I have heard of this being done using liquid nitrogen, but that sounds dangerous (could shatter the glass). I recommend trying ice water. The egg is pushed in as the air inside the bottle is chilled.

How It Works

If you just set the egg on the bottle, its diameter is too large for it to slip inside. The pressure of the air inside and outside of the bottle is the same, so the only force that would cause the egg to enter the bottle is gravity. Gravity isn't sufficient to pull the egg inside the bottle.

When you change the temperature of the air inside the bottle, you change the pressure of the air inside the bottle. If you have a constant volume of air and heat it, the pressure of the air increases. If you cool the air, the pressure decreases. If you can lower the pressure inside the bottle enough, the air pressure outside the bottle will push the egg into the container.

It's easy to see how the pressure changes when you chill the bottle, but why is the egg pushed into the bottle when heat is applied? When you drop burning paper into the bottle, the paper will burn until the oxygen is consumed (or the paper is consumed, whichever comes first). Combustion heats the air in the bottle, increasing the air pressure. The heated air pushes the egg out of the way, making it appear to jump on

the mouth of the bottle. As the air cools, the egg settles down and seals the mouth of the bottle. Now there is less air in the bottle than when you started, so it exerts less pressure. When the temperature inside and outside the bottle is the same, there is enough positive pressure outside the bottle to push the egg inside.

Heating the bottle produces the same result (and may be easier to do if you can't keep the paper burning long enough to put the egg on the bottle). The bottle and the air are heated. Hot air escapes from the bottle until the pressure both inside and outside the bottle is the same. As the bottle and air inside continue to cool, a pressure gradient builds, so the egg is pushed into the bottle.

How to Get the Egg Out

You can get the egg out by increasing the pressure inside the bottle so that it is higher than the pressure of the air outside of the bottle. Roll the egg around so it is situated with the small end resting in the mouth of the bottle. Tilt the bottle just enough so you can blow air inside the bottle. Roll the egg over the opening before you take your mouth away. Hold the bottle upside down and watch the egg 'fall' out of the bottle. Alternatively, you can apply negative pressure to the bottle by sucking the air out, but then you risk choking on an egg, so that's not a good plan.

Cloud in a Bottle Materials

- 1-litre bottle
- warm water
- match

Let's Make Clouds

1. Pour just enough warm water in the bottle to cover the bottom of the container.
2. Light the match and place the match head inside the bottle.
3. Allow the bottle to fill with smoke.
4. Cap the bottle.
5. Squeeze the bottle really hard a few times. When you release the bottle, you should see the cloud form. It may disappear between 'squeezes'.

How Clouds Form

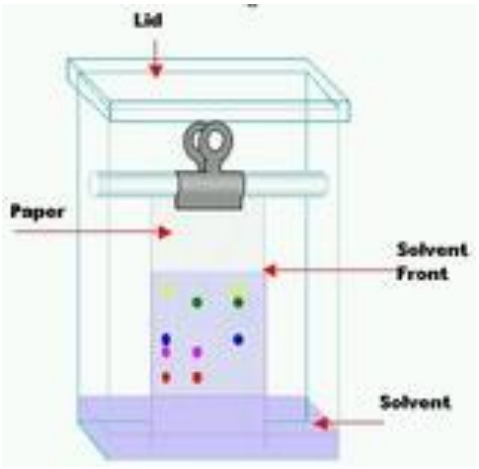
Molecules of water vapor will bounce around like molecules of other gases unless you give them a reason to stick together. Cooling the vapor slows the molecules down, so they have less kinetic energy and more time to interact with each other. How do you cool the vapor? When you squeeze the bottle, you compress the gas and increase its temperature. Releasing the container lets the gas expand, which causes its temperature to go down. Real clouds form as warm air rises. As air gets higher, its pressure is reduced. The air expands, which causes it to cool. As it cools below the dew point, water vapor forms the droplets we see as clouds. Smoke acts the same in the atmosphere as it does in the bottle. Other nucleation particles include dust, pollution, dirt, and even bacteria.

How To Do Chromatography with Sweets and Coffee Filters

You can do paper chromatography using a coffee filter to separate the pigments in coloured candies, like Skittles™ or M&M ™ candy. This is a safe home experiment, great for all ages.

Difficulty: Easy

Time Required: about an hour



What You Need:

- Skittles or M&M sweets
- coffee filter
- tall glass
- water
- table salt
- pencil
- toothpicks
- plate or foil
- pitcher or empty 2-litre bottle
- measuring cups/spoons

Here's How:

1. Coffee filters usually are round, but it's easier to compare your results if the paper is square. So, your first task is to cut the coffee filter into a square. Measure and cut a 3x3" (8x8 cm) square from a coffee filter.
2. Using a pencil (ink from a pen would run, so pencil is better), draw a line 1/2" (1 cm) from the edge of one side of the paper.
3. Make six pencil dots (or however many colours of candy you have) along this line, about 1/4" (0.5 cm) apart. Underneath each dot, label the colour of the candy you will test on that spot. You won't have space to write the whole colour name. Try B for blue, G for green, or something equally easy.
4. Space 6 drops of water (or however many colours you are testing) equally distant on a plate or piece of foil. Position one candy of each colour on the drops. Give the colour about a minute to come off into the water. Pick up the candy and eat it or throw it away.
5. Dip a toothpick into a colour and dab the colour onto the pencil dot for that colour. Use a clean toothpick for each colour. Try to keep each dot as small as

possible. Allow the filter paper to dry, then go back and add more colour to each dot, a total of three times, so you have lots of pigment in each sample.

6. When the paper is dry, fold it in half with the colour sample dots on the bottom. Ultimately, you are going to stand this paper up in a salt solution (with the liquid level lower than the dots) and capillary action is going to draw the liquid up the paper, through the dots, and toward the upper edge of the paper. The pigments will become separated as the liquid moves.
7. Prepare the salt solution by mixing 1/8 teaspoon of salt and three cups of water (or 1 cm^3 of salt and 1 liter of water) in a clean pitcher or 2-liter bottle. Stir or shake the solution until it is dissolved. This will produce a 1% salt solution.
8. Pour the salt solution into a clean tall glass so that the liquid level is 1/4" (0.5 cm). You want the level to be below the sample dots. You can check this by holding the paper up against the outside of the glass. Pour out a little salt solution if the level is too high. Once the level is correct, stand the filter paper inside the glass, with the dot side down and the edge of the paper wetted by the salt solution.
9. Capillary action will draw the salt solution up the paper. As it passes through the dots, it will begin to separate the dyes. You will notice some candy colours contain more than one dye. The dyes separate because some dyes are more likely to stick to the paper, while other dyes have a higher affinity for the salt water. In paper chromatography, the paper is called the 'stationary phase' and the liquid (salt water) is called the 'mobile phase'.
10. When the salt water is 1/4" (0.5 cm) from the top edge of the paper, remove it from the glass and place it on a clean, flat surface to dry.
11. When the coffee filter is dry, compare the results of chromatography for the different candy colours. Which candies contained the same dyes? These are the candies that have corresponding bands of colour. Which candies contained multiple dyes? These are the candies that had more than one band of colour. Can you match any of the colours with the names of the dyes listed on the ingredients for the candies?

Tips:

1. You can try this experiment with markers, food colouring, and powdered drink mixes. You can compare the same colour of different sweets, too. Do you think the pigments in green M&Ms and green Skittles are the same? How can you use paper chromatography to find the answer?