CANDY CHROMATOGRAPHY (1 Hour)

Addresses NGSS
Level of Difficulty: 3
Grade Range: 3-5

OVERVIEW
In this activity, students will use paper chromatography to separate the colors in the dyes used to color candies. (Please note: some candies are processed in factories with peanuts, so colored markers may be used as an alternative if you have students with peanut allergies)

Topic: Chromatography

Real World Science Topics
• An exploration of the components of solutions such as dyes.
• An exploration of methods of separating solutions and analyzing them.

Objective
Students will gain an understanding of techniques for measuring acidity, as well as using known standards to measure the properties of unknown solutions.

Materials Needed for Demonstrations
large bowl – clear and large enough for students to see water inside
red and blue food coloring
water
large bag of colored candies (can be the candy used for the lab)
several small containers of colored sand (alternatively – different colored sugar crystals like those used for decorating cakes)

Materials Needed for Pre-Class Preparation
clean two-liter bottle
small plastic spoon
salt

Materials Needed for Each Team of 2-4 students
2 coffee filters (should be at least 15 cm across)
candy-covered chocolate pieces of 6 different colors
3 pencils
paper towels
aluminum foil – 1 piece, 20 cm long, standard roll width wide
6 toothpicks
eyedropper (alternate: plastic straws, cut in half; bend and tape one end closed and squeeze straw to draw up water)
colored pencils
pie pan (at least 25 cm wide)
beakers or books (needed to prop up pencils)
Preparation
1. Create a salt solution by pouring water into the two-liter bottle until it is about 90 percent full. Then pour two spoonfuls of salt into the bottle. Put the lid on the bottle and shake it until the salt has completely dissolved.

NGSS Three-Dimensions

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<tr>
<td>• Develop a model to predict and/or describe phenomena.</td>
<td>• Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants.</td>
<td>• Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.</td>
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1. **Warm-up Activity:** Show your students a bowl of water and a bottle of red food dye. Ask them what they think will happen if you put some of the dye in the water. They should recognize that the water will turn red. Add a few drops of red food dye to the water and stir to distribute the dye. Now hold up a bottle of blue food dye. Ask them what they think will happen when they add the blue food dye to the bowl. They will probably guess that the water will turn purple, as they should be aware that mixing red and blue dyes produces a purple dye. Add a few drops of blue food coloring to the water and stir to distribute the dye. The water should now be purple (the intensity of the color will depend on how much water and dye you used).

Show your students a paper towel, and ask them to predict what will happen to the towel if you dip the bottom of it in water. They will probably guess that the paper towel will soak up the water and turn purple. Dip the bottom of the paper towel into the water in the bowl and have the students observe how the water creeps up the towel. Point out that the paper towel turns purple as the water creeps up. Ask students to infer why the paper towel turns purple. They should guess that the towel absorbs both the water and the dye.

2. Distribute the *Candy Chromatography* handout and materials to each group of 2-4 students. Remind students not to eat the candy used in this lab or any other materials in scientific labs.

3. Have the students cut two coffee filters into six rectangular strips approximately 10cm long and 3cm wide. Then have the students use a pencil to draw lines across the strips, about 2cm from one end. To save time you may want to perform this step ahead of time. **Each strip will be used to test a different candy color.** Below the line the students should use a pencil to write a letter for each candy color that they will use in the activity. A diagram detailing the steps in this activity can be found before the student handout.

4. Pour some salt solution into each group’s pie pan to a depth of about 2cm.

5. Next, students will extract the dye from the shell of the candy. To do this, they will need to first use an eye dropper to place six small pools of salt water (from the pie pan) on a piece of aluminum foil. Make sure the foil is flat on the table, so that the water will form small beads instead of running together. Alternatively, students can make six small indentations in the foil using their fingers, and place the salt water in these indentations. Tape the corners of the foil down if necessary. Students should use about five drops of salt water for each pool. The less water that is used, the more concentrated the dye will be. The pools should be placed far enough apart that they do not run into each other. If the pools touch, have students wipe the foil clean with a paper towel and start over.

6. Students should place one candy into each pool. They should place a different colored candy in each pool. After a few moments, the dye from the candy coating should start to dissolve in the salt water. (The water will become colored.) Students should use a toothpick to flip each candy over to dissolve the dye from both sides. Students should use a separate toothpick for each candy and should avoid touching the candies with their fingers in order to minimize mixing of the dyes.
7. Students can now transfer the dye to the coffee filter strips. Students should place a toothpick in the dyed water in each well so that some of the water sticks to the toothpick. They should then press the tip of the toothpick against one of the coffee filter strips, just above (toward the unlabeled side of) the pencil line. This should produce a spot of dyed water on the filter paper. Students should use a separate toothpick for each color (they can reuse the toothpicks they used in step 6). The spot for each color should be dark enough to be distinct, so students may need to apply the colored water two or three times for each color. After they have applied the dyes, students should tape the six strips to the pencils, with the labeled side hanging down at the bottom. They should tape two strips to each pencil, allowing at least 2 cm between strips.

8. Finally, students are ready to perform the chromatography. To perform this final step, students should suspend the ends of their strips in a shallow pool of water in their pie pan. The water should just come up to the pencil line or a little below it; the dye spot should be above the water. Students can use beakers or books to hold up the ends of the pencils while the water slowly creeps up the paper. It will take two-three minutes for the water to creep up the paper. Once the water has reached the tops of the filters, have the students place the filters on a paper towel to dry.

9. Have students use colored pencils to draw their observations of the patterns that result for each of the colors. The exact results will depend on which candy colors and brands you use for this activity.

10. **Wrap-up Activity:** Discuss with students why they could not see that the candy dye was actually made up of different colors of dye. Start off by showing the students a mixture of different colored candies in a bowl. Ask the students if they can see that the mixture is made up of different colored candies. They should be able to see this easily.

    Next, show them several different colors of sand. (Alternatively, you can use different colors of sugar crystals, such as those used to decorate cakes and cookies.) Mix them together in the bowl. Ask the students to describe the contents of the bowl. Does it look like one color or many colors? From close up it might look like many colors, but from a distance it will probably look like just one color if it is mixed well. Ask them how this might relate to their observations in this investigation. They should recognize now that the reason they cannot see the different colors in the dyes is that the particles that make up the dyes are very small. When they are mixed together, they look like one solid color. This is called a solution.

**Candy Chromatography Extension Activity**

Now that students have seen the colors that result from candy chromatography, perform the same experiment for the class with another set of dyes – for example, different colored markers, or different types of colored candy. Before you perform the demo, have the class make a prediction about what colors make up the dyes that you are using.
Why does the water move up the filter?
To understand why the water moves up the filter, it helps to think about the forces that are acting on the water. Gravity acts to pull the water molecules downward. The water molecules are also attracted to each other—a phenomenon called cohesion. The water molecules are also attracted to the fibers in the coffee filter. This attraction is known as adhesion. The adhesive and cohesive forces on the water molecules are strong enough to draw them upward against the force of gravity. These forces cause the water to move up through the filter. If the adhesive forces between the filter and the water were weaker, the water would not move up the filter.

Why do the colors separate and move at different rates?
The colors in the dye dissolve in the water. You can see this dissolution when you place the candies in water to extract the dye. The dye dissolves because the molecules in the dye are more attracted to water than to each other or to the candy shell. As the water moves up the paper, the dye moves with them. Some colors of dye are more attracted to the water than others. Some are also more attracted to the paper, which slows them down. This attraction causes the different colors in the dye to separate and move up the paper at different rates.

What are some other types of chromatography?
Paper chromatography is just one type of chromatography. All types of chromatography involve separating the components of a mixture based on their relative attractions for different substances. Chromatography generally involves a stationary phase and a mobile phase. The stationary phase is the phase that doesn’t move. In paper chromatography, the stationary phase is the filter paper. Other stationary phases include liquids, gases, and glass plates. The mobile phase refers to the part that does move. In this activity, the mobile phase is the salt solution. In other types of chromatography, the mobile phase could be another type of liquid or a gas. The type of chromatography to use depends on the type of solution one is trying to separate.

What are some real world uses of chromatography?
There are many uses of chromatography in science and industry. Among the first uses of chromatography was the separation of the different pigments that make up chlorophyll. Forensic scientists can use chromatography to identify drugs and other substances. Bioengineers use different types of chromatography to separate proteins from a sample for further study. Environmental scientists use chromatography to analyze a water sample for certain types of pollution. Chromatography can be used in most cases in which a mixture must be separated into its constituent parts.

Key Vocabulary
Solution: a mixture that looks consistent throughout
Chromatography: a technique for separating solutions
**STEP 1**
Cut two coffee filters into three strips.

**STEP 2**
Draw a line on each strip 2cm from the bottom.
Label each strip using pencil.

**STEP 3**
Use toothpick to apply spot of dye.

**STEP 4**
Hang strips from a pencil with tape.

**STEP 5**
Suspend end of strips in the water. The water should be no higher than the pencil line.
What happened to the water when the teacher put the paper towel in the colored water?
[The water rose up the coffee filter until it reached the top.]

What happened to the dye on the candy when it was put into water?
[The dye ran off into the water.]

Use colored pencils to record the results of the chromatography for each of the colors.
What happened to the water when the teacher put the paper towel in the colored water?

What happened to the dye on the candy when it was put into water?

Use colored pencils to record the results of the chromatography for each of the colors.