Bay Area Scientists in Schools Presentation Plan

Lesson Name **CSI – Chromatography Science Investigation**
Presenter(s) Swati, Benson, Irene, Jillian

Grade Level 5th **Standards Connection(s)** Physical Sciences

CA Science Standards: 5th grade Physical Sciences: Elements and their combinations account for all the varied types of matter in the world.

-Students know scientists have developed instruments that can create discrete images of atoms and molecules that show that the atoms and molecules often occur in well-ordered arrays

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

Next Generation Science Standards:

Connections by topic:

5-PS1 Matter and its interactions

5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen

5-PS1-3. Make observations and measurements to identify materials based on their properties

5-PS1-4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances

Scientific and Engineering Practices explored:

1. Asking questions and defining problems
3. Planning and carrying out investigations
4. Analyzing and interpreting data
6. Constructing explanations and designing solutions
7. Engaging in argumentation from evidence
8. Obtaining, evaluating, and communicating information

Crosscutting concepts explored:

1. Patterns
2. Cause and effect: Mechanism and explanation
5. Energy and matter: Flows, cycles, and conservation
6. Structure and function
7. Stability and change

Foss connections:

5th grade physical science: Mixtures and solutions

FOSS expects students to…

- Learn that all matter is made of very small particles called atoms and that atoms combine to form molecules and compounds
- Plan and conduct simple chemical investigations
- Use measurement and appropriate tools in the context of scientific investigations
- Record data, develop scientific evidence, and draw conclusions from that evidence

Teaser: *With some household materials and the scientific method, you can use a chemical "fingerprint" to help solve a crime! Students will use chromatography to separate the colors found in various inks, then use what they've learned in a fun detective activity.*

Objective: Students will learn how scientists use the scientific method of forming hypotheses, designing and conducting experiments, and interpreting results to draw conclusions. They will understand that some substances can contain a mixture of more than one component.

Vocabulary/Definitions:

3 – 6 important (new) words

- Hypothesis: a prediction based on knowledge that can be tested
- Experiment: a test used to support or reject a hypothesis
- Chromatography: A separation method for a mixture of molecules
  - -Chroma and Graphein as word parts
- Solvent: a liquid part of a solution
- Molecule: a group of atoms making an individual unit of a chemical

Materials:

- A copy of the lesson plan for each team member
- Lesson kit (provided by CRS)
  - Black, Red, Green, and Blue Sharpie® Flip Chart markers
  - Coffee filters, cut into 2.5" x 3.5" rectangles
  - Laboratory filters, cut into 2.5" x 3.5" rectangles
  - Wooden coffee stirrers
  - Ziploc® 4-cup containers
  - Black pens: Uni-ball Roller Fine, PaperMate Flair Medium, Sharpie Ultra Fine
  - Four sheets of lab filter paper, each with a black smiley face from a different pen/marker in the bottom left corner. (*You may want to prepare these just before Experiment 2 so that the*

inks separate well)

- Ask if there will be access to a sink in the classroom; if not, make sure to bring adequate water
- The kids should have access to scrap paper, their own pencils, and, if possible, a ruler.

Classroom Set-up:

Student grouping, Power/Water, A/V, Light/Dark, set-up/clean-up time needed

- Have a table or several desks set up at the front of the classroom for demonstrations
- Have the teacher divide the class and their desks into four groups.

Classroom Visit

1. **Personal Introduction:** **5 Minutes**

   Introduce yourself and what you do as a scientist—i.e. your elevator pitch. Talk about what you love about science, your favorite scientific activity, your favorite non-scientific activity, and why and how you got into your career.

   Topic Introduction: **5 Minutes**

   Find out what the students know about science, about chromatography/chemistry, and about **hypotheses**, **molecules**, and **solutions**.

   As scientists, we use a number of tools to help us determine what makes up a **substance**. We can learn about what's inside chemical solutions by using **chromatography** to see all of the different elements inside. Sometimes, we're not sure which tools are the best for looking at all the ingredients, so we use several different techniques.

2. **Learning Experience(s):**

   Experiment 1: Colors **25 Minutes**

   For this experiment, each group is going to use different tools to try to see what makes up the colors of each of our markers. We'll be testing two different filter papers (one made for coffee and one made for the laboratory) and two different **solvents** (water and vinegar). By looking at the different combinations of the different papers and solvents, we can figure out which is the best for seeing the different parts of each color.

   - Have the teacher divide the class into four groups, and number each group.
   - To each group, distribute a black, purple, red, orange, green, and blue marker, a plastic tub with lid, two binder clips and two pencils.

   <u>There are many ways to conduct this next step, so pick one of these (or a different one) that works for your group:</u>

   - Two groups will receive two pieces of coffee filter paper, and two groups will receive two pieces of laboratory filter paper.

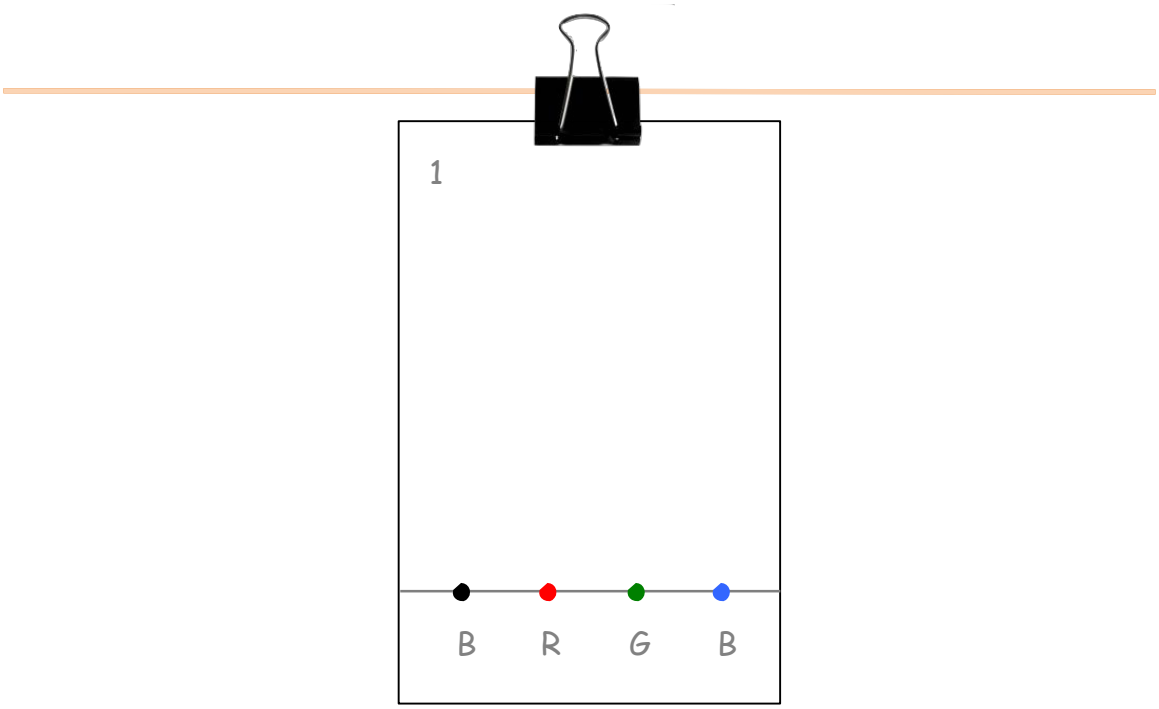
   -If each of your four groups is large enough (n=8 maybe) then each group can get two pieces of coffee filter and lab filter paper each with both of the solvents, then they can conduct the experiment within their small group and talk about it.

   -Your four groups could also be split up with each group having a different paper/solvent combination : Coffee-Water, Coffee-Vinegar, Lab-Water, Lab-Vinegar and they could come

together as a class and discuss it.

- With their own pencils and a ruler, have each group draw a line in pencil lengthwise across the sheet of filter paper, approximately 1/4” from one edge. This edge is now the bottom of the paper.
- Using the markers, have the students place a small dot on the filter paper such that each dot is roughly evenly spaced. **Make sure to give them this direction or else they may overlap their dots and compromise the experiment.** The paper will readily absorb the marker, so a simple touch with the marker will suffice. When the first dot dries, have them dot each spot again with the same color. (*Note: colors may bleed through the filter paper, so they should have scrap paper underneath the filter paper while they are doing this*.
- Go around to each group and bring them each solvent in a Tupperware container depending on your grouping scheme. No matter what, make sure you have four different paper/solvent combinations: water/coffee, water/lab, vinegar/coffee, and vinegar/lab.
- Beneath each dot, have the students write the first letter of the color in pencil
- Using the medium-size binder clips, have the students put the binder clip around the wooden stirrer, and then clip the top of the paper to the pencil. Make sure the paper is parallel to the stirrer.

(*Hand out the following diagram, but you may want to also draw it on the board, and/or demonstrate with your own set of materials:*)



Pre-experiment questions:

- *What do you think will happen when we put the paper in the solvent?*
- *What colors do you think you will see when each dot is separated out?*
- *Do you think the coffee filter paper and the lab filter paper will produce different results?*
- *Do you think the water and the vinegar will produce different results?*
- *Why are we running each experiment twice?*
- *Which combination do you think will give us the best results? Why?*

- When each group is ready, have them hang their stirrer-clip-paper setups across the Ziploc container. The paper should be just barely touching the bottom of the solvent, and the bottom of the paper should be horizontal.
-There should be enough solvent in the bottom of the container such that the bottom of the paper is immersed, but the colored dots do not touch the solvent.

As the solvent is separating the pigments, describe to the students what is happening inside the paper. Explain that the ink in every marker is made up of a bunch of different molecules. Since the different molecules have different affinities for water, water will carry them up a piece of filter paper at different speeds and separate the components in a process known as ***chromatography****.*

- After about five minutes or when the top of the solvent is close to the binder clip, have the students gently lift the paper out of the water and set it on the scrap paper to dry. Observe the colors in each marker's track.

Post-experiment questions:
- *What colors do you see in each track? Did any colors move farther than others?*
- *Which paper do you think is better for looking at the different colors? Why?*
- *Which solvent do you think is better for looking at the different colors? Why?*
- *What combination of paper and solvent should we use if we want to get the best idea of what's inside a color?*

Experiment 2: Crime-solving time! 15 Minutes

****Note1: Check with the teacher first to make sure she's willing to take the fall for the crime! If not, then utilize a backup plan. (i.e. one of the scientists on the team committed the crime)**
****Note2: If you'd like the stolen item to be candy, you may bring some. If you do, check with the teacher to make sure that candy is allowed in her classroom. If not, just "a crime" that doesn't involve sugar can be used instead.**

The Smiley Bandit has struck again! Or so it would seem...

Someone has stolen something precious from four different crime scenes across the city! All of them left behind the calling card of the Smiley Bandit: a card with a telltale smiley face on it. We managed to catch the person we think could be the Bandit, and (s)he was even holding a black

pen in her hand! But did our suspect perpetrate any of these crimes, or were they just copycats? It's up to you, our detectives, to find out!

Each group will get one of the cards left at one of the crime scenes. Using chromatography, you will compare the smiley face left at the scene of the crime to the smiley face made by our suspect's pen. If the pattern matches, she's busted!

- Distribute a piece of filter paper with a black smiley face on it to each of the four groups as the papers found at the "scene of the crime"
- This time, all groups will be using lab filter paper and water as a solvent.
- Have the teacher and three other "suspects (the other instructors)" draw smiley faces with different pens next to the smiley from the crime scene on each group's card using a different kind of black pen than the one the teacher/bandit used.
- Follow the previous procedure for writing the group number in the upper left corner, and clipping the paper to the pencil.
- All groups will be re-using the containers holding water, so they will have to share containers.
- Have the detectives carefully put the pencils on the edges of the containers, so the bottoms of the papers are just barely immersed in the water. Remember to make sure the paper is as horizontal as possible.

As the ink travels up the paper, explain to the students that, just as the black marker contained different parts of other colors, different black inks can contain different pigments with different size molecules. Each pen will thus have a unique "fingerprint" of ink, and with chromatography, we can see if the ink from the crime scene matches the ink from the suspect.

- After the solvent is a few cm from the top, have the groups remove their paper and examine it to decide which suspect is our criminal.
- *Which suspect committed the crime?*

3. Wrap-up: Sharing Experiences **5 Minutes**

Have the students summarize the results of each of the experiments. Talk about how laboratory equipment is specially designed to allow for more consistent results, and the importance of repeating experiments so that scientists can verify results. Go over the new vocabulary covered in the lesson.

4. Connections & Close: **5 Minutes**

What else might kids relate this to from their real-life experience? How can they learn more? What careers might they explore if they like using this tool? Thanks and good-bye! Clean-up.

Total <u>50 – 60</u> Minutes

Follow-up – After Presentation

Suggest students write a letter explaining "How we learned about _____?"
List or attach examples of activities, websites, connections for additional learning.
Attach worksheets, hand-outs, visuals used in classroom presentation.

1611 San Pablo Avenue, Suite 10B
Berkeley, California 94702
(510) 527-5212 • www.crscience.org