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iBIO STEM Kit: Chromatography Part 1

iBIO STEM Kit welcomes you to a SCIENTIFIC JOURNEY!

Today, we will be investigating **methods for separating mixtures**. The purpose of this investigation is to challenge you to separate the materials using their properties. After physically separating a mixture, we will use paper chromatography to separate food dyes from solution. We also challenge you to explore this chemistry problem as a scientist would. What does this mean?

Scientific exploration is different than just playing around because it asks you to think about HOW you investigate. This means you need to do your investigation by observing what happens when you change a variable you have carefully chosen. This helps you to understand WHY something happens. Scientific exploration also means that you record WHAT you see or measure and that you record WHY you think it happens. The Young Scientist Journal that you are holding will help to guide your investigation and give you a place to record your observations, measurements and conclusions.

Follow the QR code at the top of the page for additional resources on this activity. There are many resources for you to use on our website. This type of investigation is associated with some very exciting careers! We hope that you will explore these resources while you are doing your investigation!

Let's Get Started!

FIRST, you will need to prepare your workspace. This can be a very wet and messy investigation, so make sure that you are using a space that will not be easily damaged. A kitchen table will work nicely. To make your clean up easier, you should protect your surface by laying out some used newspaper or opening up a paper grocery bag.

SECOND, you want to lay out your materials. Use the list below to identify which materials are used in each part and organize them in your workspace. There are some additional materials that you will need to supply from your home.

Materials for Part A:

- A MIXTURE in a plastic bag
- A ceramic magnet
- 4-9 oz cups
- Plastic spoon
- Piece of wool felt

Supplied from home:

- Water
- A piece of paper

Materials for Part B:

- 2 medicine cups
- Grape Kool-Aid & Lemon-Lime Kool-Aid
- Plastic spoon
- 2 chromatography paper strips
- 2 cotton swabs
- 1 tsp of salt
- 3-9oz cups
- Two small binder clips
- Two craft sticks

Materials from Welcome Kit:

- Ruler
- Pencil

Supplied from home:

- Water

LAST, you need to be prepared for experimenting safely. Always be careful when working with chemicals (even if they do not seem hazardous) to prevent injury. DO NOT eat or drink the Kool-Aid.

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Chromatography-Chemistry

Part A: How can we use the properties of materials to separate a mixture?

What is a mixture?

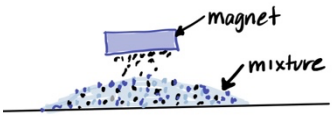
A mixture is made when two or more materials are combined, but they are not combined chemically. That means that when you look at the mixture, you can still see each item as a separate thing. Each of the materials could be easily separated from one another. The materials in a mixture still have their own properties.

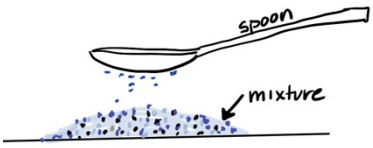
Here's what you will need to separate your mixture:

- A MIXTURE in a plastic bag containing these materials:
  - •Salt
  - •Sand
  - •Iron filings
  - •Black pepper
- A ceramic magnet
- 9 oz cup that is half-filled with water
- Extra 9 oz cups
- Plastic spoon
- Piece of wool felt

From home:

A piece of paper that you can use as a surface to unmix your mixture!





You have a plastic bag that contains a mixture of salt, sand, iron filings and black pepper. If you look carefully at the mixture, you should be able to identify each material. You could actually pick them apart and move them into separate piles, but that would take a long time. An easier way to separate a mixture is by using the properties of each material to do the separation for you. Let's try it out!

<u>Important ideas for separating a mixture:</u>

1. **Magnet:**
   Magnets create an invisible charged field around themselves that can attract or pull on some metals. If a material in a mixture is attracted to a magnet, the magnet will pull that material to the magnet. This force can be used to move it out of the mixture.

   One of the materials in the mixture can be moved by a magnet! Take your magnet and run it over the mixture, and one of the materials will easily lift out of your mixture! Remove that material and put it into a pile on your paper. Which material is it? **Find its name on Table 1 and record your observations there.**

2. **Static Electricity:**
   Static electricity can be **created** by rubbing one object against another object. This is because the rubbing releases negative charges, called electrons, which can build up on one object to produce **a static** charge. This charge is attractive to the opposite charge.

   One of the materials is lightweight and will be lifted out of the mixture by static electricity. This is easily done by rubbing your piece of wool felt on the plastic spoon. Once the static electricity is made, hovering the spoon over the mixture will cause the component to jump out of the solution. You may have to do this many times to remove all of this material from the mixture. Make a pile of it on your paper. Which material is it? **Find its name on Table 1 and record your observations there.**

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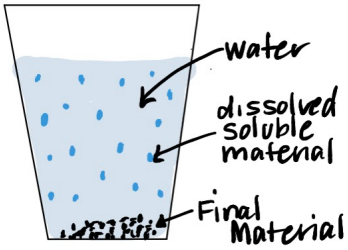

3. **Solubility**:
   Solubility is the ability to dissolve in a solvent, like water. When a material dissolves, it will no longer be visible because its molecules are hidden between the water molecules. It forms a solution. Materials that cannot dissolve will remain visible because they are not a part of the solution.

   One of your materials is soluble in water and can be removed when it is in solution. Put the remaining mixture into the cup of water and stir it with the plastic spoon. The material that is soluble will dissolve into the water. Pour your new solution into the empty cup and put it aside. Which material dissolved? **Find its name on Table 1 and record your observations there.**

4. **Final Material**:
   The final material will be left in the cup. It is not magnetic. It does not respond to static electricity and it is not soluble. Which material is it? **Find its name on Table 1 and record your observations there.**

Clean up your materials before you start Part B. You will be reusing your 9oz cups and your plastic spoon.

Table 1: Observations of the Separation of Mixture

Component of Mixture	What method did you use to move this component out of the mixture?	What was it like to use this method to remove this material?	Describe the appearance of this material. Can you still see it?
Salt			
Iron filing			
Sand			
Black pepper			

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Part B: How can we use paper chromatography to separate a solution?

What is a solution?

A **solution** is a type of mixture that consists of two or more substances dissolved in a liquid form. This means that atoms of the solute are evenly dispersed throughout the solvent. Liquid drinks are common solutions. Coffee is a solution that contains water, sugars, and proteins. Flavored drinks are solutions made of water, sugar, flavorings and food coloring.

What is paper chromatography?

Colored drink mixtures are interesting to separate. In this investigation, we will be using paper and gravity to separate the food colorings (dyes) in two different kinds of Kool-Aid. This separation technique is called **paper chromatography.** The dyes we put on a strip of paper from each type of Kool-Aid will be carried up the paper by a salt solution. Each color dye is a different size. The big dyes will be heavy and will not move very quickly against gravity. The smaller dyes will be lighter and will move more quickly up the paper. This will separate them so that we can see each color in the Kool-Aid solution!

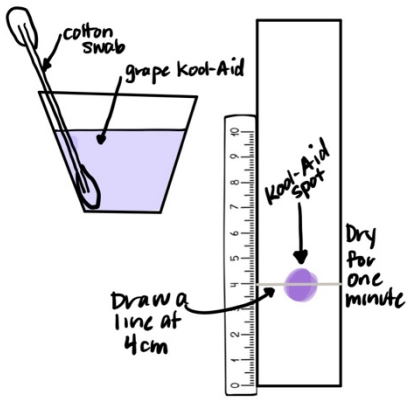
Note: This can get messy, so make sure you have covered your workspace!

Here's what you will need to make your solution:

- 2 medicine cups
- Water
- Grape Kool-Aid
- Lemon-Lime Kool-Aid
- Plastic spoon (from part 1)

Here's what you will need to set up your paper strip:

- 2 chromatography paper strips
- Ruler
- Pencil
- Lemon-Lime Kool-Aid solution
- Grape Kool-Aid solution
- 2 cotton swabs



Setting up your solutions:

1. Your medicine cups are marked so that you can measure with them. Put 20 ml of water in each of your medicine cups.
2. Open the grape Kool-Aid and pour all of the powdered mixture into one of the medicine cups. Use the spoon to stir the mixture until it is dissolved. Rinse the spoon-you will be using it again.
3. Open the lemon-lime Kool-Aid and pour all of the powdered mixture into one of the medicine cups. Use the spoon to stir the mixture until it is dissolved. Rinse the spoon--you will be using it again.

Setting up your paper strip:

4. Take your first paper strip and lay it out in front of you.
5. With your ruler, measure 4 centimeters from the bottom. Make a line with your pencil across the width of the paper. At the top of the paper, write "Grape". It should look like the picture.
6. Take the Grape Kool-Aid Solution and a cotton swab. Stir the solution with the cotton swab so that the cotton swab is soaked.
7. Dab the cotton swab on the edge of the medicine cup or on a piece of paper towel to make sure that the cotton swab is not too wet. Lightly touch the swab in the center of your pencil line as shown in the picture below. The solution will soak into the paper quickly. Let it dry for one minute.
8. Repeat this three more times until the mark is very dark. Put the paper and the solution aside for now.
9. Now, take your second paper strip and repeat steps 4-8 with the Lemon-Lime Kool-Aid.

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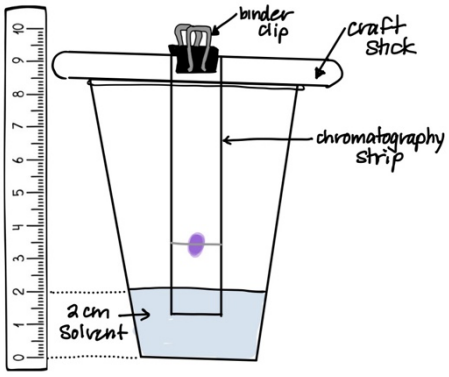
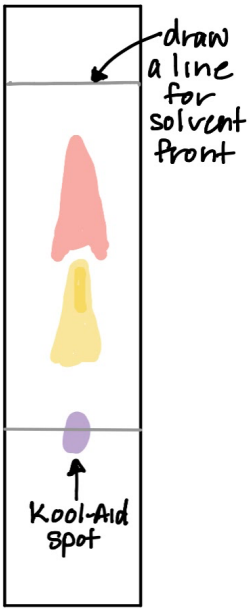
Here's what you will need to set up your chromatography cup:

- 1 tsp of salt
- 1 9 oz cup of water
- Plastic spoon
- 2 empty 9 oz cups
- Two small binder clips
- Two craft sticks
- Your Grape paper strip
- Your Lemon-lime paper strip





Setting up your chromatography cup:

10. Pour your salt into the 9 oz cup of water and stir until it is dissolved. This is your solvent. It will dissolve the dyes on the paper.
11. Set out your two 9 oz cups. Pour 2 cm of the salt solution into each cup, by holding your ruler next to the cups and pouring the solution in.
12. To set up your paper strip hanger, you need a craft stick and a small binder clip. Wrap the top of the paper strip over the craft stick as shown in the diagram.
13. Use the binder clip to secure the paper on the craft stick.
14. Place the whole hanger across the cup so that the paper strip is suspended in the liquid as shown in the diagram. You will see the salt solution begin to rise up the paper. You will need to let it sit for 5-10 minutes.
15. Now set up the Lemon-Lime paper strip hanger using directions 12-14. It will need to sit for 10 minutes as well.
16. Soon you will see the food coloring in the Kool-Aid begin to move up the paper as well. The solvent is dissolving the dyes and carrying them up the paper. You will need to let it sit for 10 minutes to see the complete separation of the dyes in the paper.

When the solvent is close to the top:

17. After 10 minutes, remove the paper strip holders and remove the paper strips from the craft stick.
18. With your pencil, draw a line across the top edge of the wet area of the paper strip. This is called the **solvent front**. It is how far the salt water was able to move up the paper.
19. Allow your paper strip to dry and then tape your paper strips in Table 2.
20. What do you see? What does it tell us about the different Kool-Aid mixtures?

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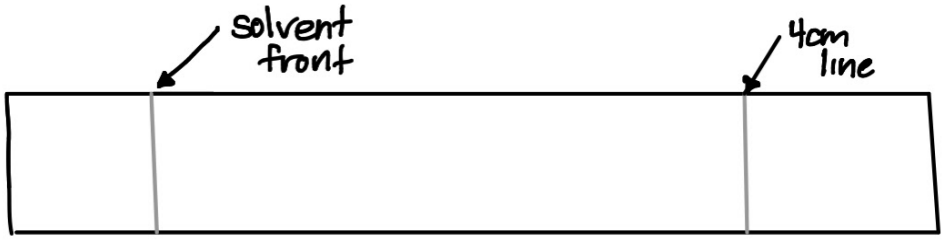
Table 2: Analyzing the Paper Strips

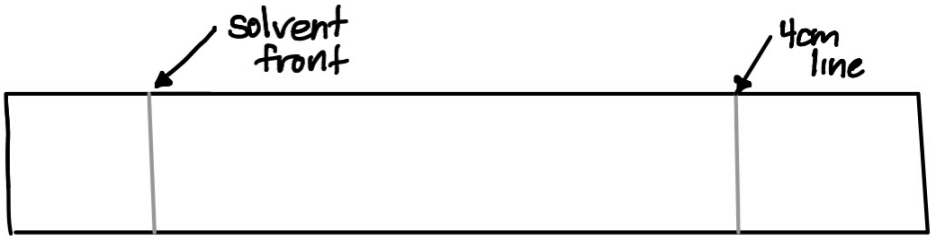
Each color dye is a different size. The big dyes are heavy and will not move very quickly against gravity. The smaller dyes are lighter. They move more quickly up the paper and will be closest to the solvent front.

Tape your GRAPE KOOL-AID Paper strip on top of the drawing below. There should be two colors. Label one color dye 1 and the second color dye 2.



What color is Dye 1: _____	What color is Dye 2: _____
This is the (**larger dye** or **smaller dye**) (circle answer)	This is the **(larger dye** or **smaller dye**) (circle answer)
How far did the dye move? Circle the answer. All of the way! Not quite all of the way. Halfway Not quite halfway	**How far did the dye move? Circle the answer.** All of the way! Not quite all of the way. Halfway Not quite halfway

Tape your LEMON-LIME KOOL-AID Paper strip on top of the drawing below:



What color is Dye 1: _____	What color is Dye 2: _____
This is the (**larger dye** or **smaller dye**) (circle answer)	This is the **(larger dye** or **smaller dye**) (circle answer)
How far did the dye move? Circle the answer. All of the way! Not quite all of the way.	**How far did the dye move? Circle the answer.** All of the way! Not quite all of the way.

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Halfway Not quite halfway	Halfway Not quite halfway