Ransom Note

Lesson Concept Chemical and physical properties of substances are used to separate mixtures and identify compounds.

Link Mixtures and solutions can be separated into their original components. Different mixtures can be separated via different methods.

Time 2 Class Periods

Materials

Whole Class
480 ml (2 cups) saltwater
Masking tape
3 cut white carnations
1 tall vase
Water

Per Group (groups of 4)
240 mL (1 cup) sand
60 mL (1/4 cup) iron filings
1 funnel (for clean-up)
5 pieces of chromatography paper (coffee filters may be substituted)
1 small bottle of each color (red, green, yellow, blue) food coloring
5 small plastic cups
1 small plastic plate (or cup)
1 box toothpicks
1 stapler
Pencils-for labeling chromatography paper
8 sets of 5 black felt pens (e.g., Faber-Castell™, Stylist™, Express™, and Papermate™)
1 magnet
1 paper towel

Ransom Note Lab Paper

Individual

Science Notebook

Advance Preparation

1. Set out trays of mixed sand and iron filings.

2. Place four different food colors in four small plastic cups, in a fifth cup mix all four food colors. Put a toothpick in each cup.

3. Prepare copies of Ransom Note Lab Papers (1 copy per group),

4. In this activity, students must decide which ink pen wrote a ransom note. Before class, write a fake ransom note with a black ink pen on a piece of filter paper. You could make the note say anything you want, such as.... "If you want the classroom digital camera returned, put $250.00 in an envelope and leave it under the big plant in the school lobby at 2:30. Come alone and leave as soon as you leave the money." Wrap a piece of masking tape around each of 5 black ink pens and number them from 1 to 5. Make sure you remember which number wrote the ransom note.

5. Prepare a demonstration set of all materials to be used by the teacher.

Background Information for the Teacher: Food Dye Activity
In this activity, the capillary action of water moves a sample solution of food dye through a piece of paper in order to separate each sample into its component colors. As the water moves up, the component colors are separated as follows:
1. The water moves up the paper until it meets the sample spots, which are then dissolved by the water.
2. The atoms in the colors of dye or ink interact with the atoms of the cellulose in the paper and water.
3. Different colors of dye or ink have different chemical structures, therefore interactions with the cellulose and with the water will be different.

Procedure:

Engage (15 minutes) Mixtures may be separated by their physical properties.

Day 1 Separating Mixtures

1. Conduct the following mini-experiment involving the separation of substances based on their properties.
2. Distribute the mixture of iron and sand without identifying the mixture.
3. Have the students record their observations and answer specific questions on their lab paper. Questions: How many different types of grains make up the mixture? What are the colors? Compare the sizes of the different grains. What are the shapes of the different grains?
4. Ask the students to come up with methods to separate the mixture. The students will think silently at first and then share with their partners.

5. Let the students test out their methods.
6. After about 5 minutes, give each pair a magnet to separate the mixture (it helps to cover the magnet with a paper towel).
7. Students will fill out their lab questions and adjust their method for separation of the contents of the mixture.
8. Have students think-pair-share about the following question: How were you able to separate the sand/iron mixture with a magnet? How did you know that the iron and sand were separated?

Explore (35 minutes) Mixtures may be separated by their chemical properties.

<u>Separating Food Dye</u>

9. Write your name in the upper right hand corner of your paper using a pencil.
10. Using the toothpick, put a small dot of each color 1 inch from the bottom of the filter paper. Near each dot identify the color using a pencil: R, B, Y, G, Mix.
11. Form the paper into a cylinder and staple the edges together, leaving a small gap so that the EDGES DO NOT MEET.
12. Put enough water on the plastic plate to just cover the bottom. This water is called a solvent and it is used to separate the different colors in the dyes.
13. Put the paper cylinder on the plate, placing the colored spots on the bottom. The dots of color should NOT TOUCH THE WATER!!
14. Allow the solvent (water) to rise up the filter to within 2-3 cm from the top.
15. Watch the solvent rise and note how the dots begin to separate into bands of color as they move along. This is your chromatogram. Take chromatogram out of water and allow to dry.

<u>Day 2 Who Wrote the Ransom note?</u>

16. Have students work in groups of four to conduct a lab using the same procedures they used to separate the food dye to solve a ransom note mystery.
17. Distribute the Ransom Note Lab Paper to each group. Read the following mystery with the students: Someone has stolen the classroom digital camera! We received this ransom note this morning. "If you want the classroom digital camera returned, put $250.00 in an envelope and leave it under the big plant in the school lobby at 2:30. Come alone and leave as soon as you leave the money."
18. Distribute the chromatography paper with the mystery ink already on the chromatography paper. The mystery ink should be labeled “mystery.” Distribute one set of pens to each group. Each group will state who they think wrote the ransom note and give evidence for their findings. We will talk about how people use science and chemistry to solve mysteries.

19. Distribute 5 additional pieces of chromatography paper to each group. Have students mark a chromatography paper with a dot of each pen and label the dots 1=Amber, 2=Billy, 3= Cassy, 4=Derrick, and 5=Erin.
20. Form the paper into a cylinder and staple the edges together, leaving a small gap so that the EDGES DO NOT MEET.
21. Put enough water on the plastic plate to just cover the bottom. This water is called a solvent and it is used to separate the different colors in the dyes.
22. Put the paper cylinder on the plate, placing the colored spots on the bottom. The dots of color should NOT TOUCH THE WATER!!
23. Allow the solvent (water) to rise up the filter to within 2-3 cm from the top.
24. Watch the solvent rise and note how the dots begin to separate into bands of color as they move along. This is your chromatogram. Using your chromatogram, who wrote the ransom note? How did you figure this out? Take chromatogram out of water and allow to dry.

Explain (15 minutes) Mixtures can be separated by their chemical properties.

25. Have students answer the following post-lab questions in their science notebooks: Which ink contained the greatest number of different colors? How many different chromatographs did you observe? Which ink traveled the farthest? Why did some of the colors travel more quickly up the paper? Why did some colors not travel very far? Which colors were strongly attracted to the solvent (water)? How do you know?
26. Have students complete the following sentence frame: I can infer that the colors_ _____ and _____were the most attracted to the solvent (water) because they _____

Extend (20 minutes to overnight) Capillary action can be used to separate the water and nutrients from the soil.

<u>Capillary Action in Plants</u>

27. Demonstrate capillary action in plants. Fill a tall vase with water. Add 5 drops of red food coloring. Place the cut carnations in the vase.
28. Based on their experiences thus far, ask students to predict what will happen the food coloring and the color of the carnations. Have students record their predictions in their science notebooks.
29. Have students observe the flowers throughout the day. The color should travel up the stem and color the flowers. This may take anywhere from several hours to overnight. Have students record their observations in their science notebooks.

30. Explain to students that plants use capillary action to transport water and other nutrients. This is why flowers in a vase with water can stay fresh after being cut. If food coloring is added to the flower's water supply then the transport can be observed.

Evaluate **(10 minutes) Differences in chemical and physical properties of substances are used to separate mixtures and identify compounds.**

31. Have students select one of the activities from this lesson. Have students recall the steps in the activity. Have students record the steps they followed in sequence. Encourage students to illustrate and label the steps they followed. Ask students to explain how they made a discovery by following a careful set of steps.