SCOPE, SEQUENCE, and COORDINATION

A National Curriculum Project for High School Science Education

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Student Materials

Learning Sequence Item:

930

Recognition and Classification of Mixtures

March 1996
Adapted by: Dorothy Gabel

Contents

This micro-unit was adapted by **Dorothy Gabel** (Indiana University, Bloomington)

Student Sheet

Science as Inquiry

Margarine: The Best Value

Is margarine one substance or a mixture of substances?
If it is a mixture, which is best?

Overview:

Three different types of margarine are heated in test tubes and placed in a water bath until they melt. A visual comparison of the three tests will indicate whether margarine is one substance or a mixture. Using cost comparisons and other information provided by your teacher, decide which is of greatest value.

Procedures:

Obtain from your teacher three pats of equal volume of different types of margarine (regular, light, and extra light). Place them immediately in three separate test tubes using wooden splints. (It is important to keep the margarine cold or you will have difficulty getting it into the test tube without losing any of it.)

Place the test tube in a water bath in a beaker and heat the water until the margarine in each tube melts.

Measure and record the height of each ingredient in each test tube.

1. Describe the differences among the contents of the three tubes. Do any of the tubes contain only one substance?

2. Using the heights of the ingredients, and information supplied by your teacher on the number of pats per stick, determine the percentage of margarine in each type.

3. Calculate the cost of the margarine using the information on the cost per pound of each type of margarine (supplied by your teacher) and the percentage calculated in #2.

4. Compare your answers to questions #1 and #2 by noting the information on the packages of each type of margarine.

5. Give arguments for purchasing the different margarine types. Which would you select and why?

Student Sheet

Science as Inquiry

Ink: A Single Substance?

Is ink one substance or a mixture of substances?
Can inks from different pens be identified using chromatography?

Overview:

The various colored inks from felt-tipped pens are placed on chromatography paper, which is then placed in rubbing alcohol. Examination of the resulting chromatogram will enable you to determine whether ink is one substance or a mixture of substances. Using your chromatogram, you will be able to identify the inks made from two different pens that have been superimposed on one another.

Procedure:

Measure 25 mL of rubbing alcohol and pour it into a 600 mL beaker. Cover this with a piece of plastic wrap using a rubber band. This allows the vapors to fill the beaker, and more uniform results are obtained.

Obtain a piece of chromatography paper (handle only by edges.) Place it on a clean piece of paper and with a pencil make a line 1 cm from the bottom along the length of the chromatography paper. Then make a series of small dots about 1.5 cm apart along the line, over which you will place a small dot of ink from each of the colored pens. Mark each dot with the initials of the color of the pen for identification purposes. These dots should be small, about 2 mm in diameter. Make one extra dot for your "unknown" containing the ink from two pens.

Your teacher will take two pens and superimpose the inks on the extra dot you made.

After placing the spots of ink from each pen on the paper, roll the paper carefully into a cylinder by touching only the top and bottom edges, and staple it so that the two ends do not overlap yet are held by two staples. The spots should be on the outside of the cylinder.

Place the cylinder in the beaker with the rubbing alcohol, cover with the plastic wrap and allow to stand until the ink travels to about 2 cm from the top of the paper. Then remove it and allow it to dry (30 to 40 minutes).

1. Are the inks in felt-tip pens one substance or a mixture of substances? Provide evidence to support your conclusion.

2. What two pens did your teacher use when making your unknown? Explain how you reached your conclusion.

3. What other mixtures could be separated using chromatography?

Science as Inquiry

Purifying Seawater

How can the salt from seawater be removed?

Overview:

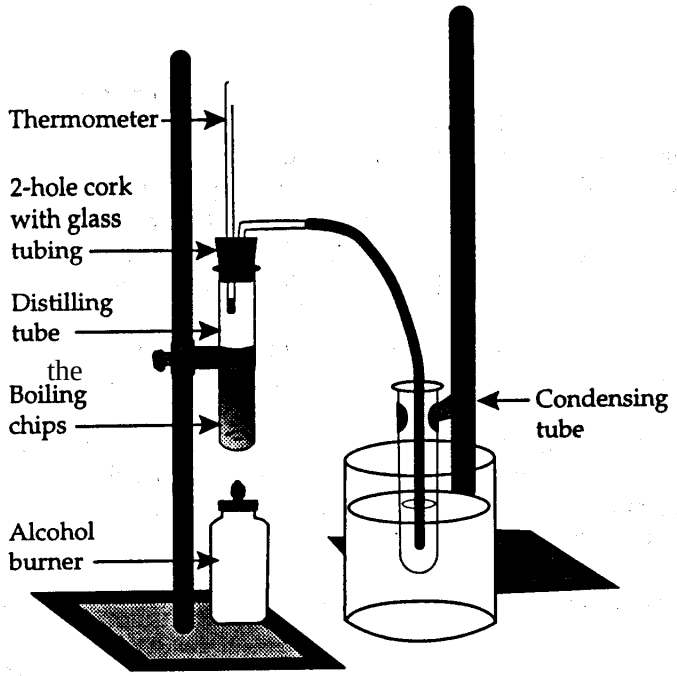
Seawater contains about 3.5% salt plus many organisms and other solid matter. In this activity simulated seawater will be distilled to separate the water from the salt and other materials.

Procedure:

Measure 25 mL of the seawater and place it in a test tube that is attached to the distillation apparatus as shown in the figure. Add three boiling chips to the seawater before inserting the stopper.

After placing the collecting tube in the ice water bath, heat the water and continue heating until almost all of the water has boiled into the collecting vessel. Make observations of the temperature and what is happening in the test tubes at various points during the distillation process.

Remove the tubing from the collection vessel and turn off the burner. Observe the contents of the two test tubes.



1. Describe the evidence that indicates that the salt has been removed from the seawater.

2. Describe the temperature changes that occur as the seawater is heated. Relate the temperature to what is occurring in the two test tubes.

3. Do you think that the temperatures that you obtained during the distillation process, when thermometer was placed in the vapor, are the same ones that would be obtained if the thermometer was placed in the seawater? Explain.

4. Explain the variation in temperatures in terms of what was happening to the water molecules during the distillation process.

Student Sheet

Science as Inquiry

Solving the Mystery

Is ink one substance or a mixture of substances?
Can inks from different black pens be distinguished using chromatography?

Overview:

The black ink from felt-tipped pens from various manufacturers is placed on chromatography paper, which is then placed in rubbing alcohol. Because the black inks from different manufacturers produce different chromatograms, they can be distinguished from one another and used to identify an unknown pen.

Someone wrote a love note to you on filter paper with invisible ink, but signed it with a marker as XXX. Your teacher will give you the love note. Who made the marking? Anne who used brand A, Barbara with brand B, Cathy with brand C, Dottie with brand D, or Evelyn with brand E?

Procedure:

Measure 25 mL of rubbing alcohol and pour it into a 600 mL beaker and cover this with a piece of plastic wrap using a rubber band. This allows the vapors to fill the beaker, and more uniform results are obtained.

Obtain a piece of chromatography paper (handle only by edges.) Place it on a clean piece of paper and with a pencil make a line 1 cm from the bottom along the length of the chromatography paper. Then make a series of small dots about 1.5 cm apart along the line, over which you will place a small dot of ink from each of the black pens. Mark each dot with the initials of the manufacturer of the pen for identification purposes. These dots should be small, about 2 mm in diameter.

After placing the spots of ink from each pen on the paper, roll the paper carefully into a cylinder by touching only the top and bottom edges, and staple it so that the two ends do not overlap yet are held by two staples. The spots should be on the outside of the cylinder.

Place the cylinder in the beaker with the rubbing alcohol, cover with the plastic wrap, and allow to stand until the ink travels to about 2 cm from the top of the paper. Then remove it and allow it to dry (30 to 40 minutes).

Your teacher will give you a "love note" containing X's from a secret admirer. Develop this chromatogram in the same manner to determine who sent you the note.

1. Are the inks in felt-tip pens one substance or a mixture of substances? Provide evidence to support your conclusion.

2. What pen was used to make the mystery writing? Explain how you reached your conclusion.

3. What other mixtures could be separated using chromatography?

Science as Inquiry

Separating Plant Pigments

**Is the green color in plant leaves one substance or a mixture of substances?
Can the green color be separated using chromatography?**

Overview:

The chlorophyll is extracted from the leaves of various trees and placed on filter paper, which is then placed in acetone. Observations are made to determine if the extracted color from the leaves separates into various components.

Procedure:

Measure 50 mL of rubbing alcohol and pour it into a 100 mL beaker. Place the beaker in a hot water bath and heat until the alcohol is near boiling. *Be careful not to heat the alcohol directly with an open flame because it is very flammable.*

To extract the chlorophyll from the leaves, cut up several leaves and place in a crucible. Transfer the hot alcohol into the crucible and grind with a pestle until the alcohol becomes dark green.

Filter the mixture into a 100 mL beaker that has been placed in an ice bath and cool the dark green solution until it reaches room temperature.

Prepare the round filter paper for use in making the chromatogram by cutting a strip 1 cm in width from the circumference to the center. This strip which is still attached to the filter paper will be used to contain the dot of chlorophyll that you will place about 2 cm from the bottom. Use a toothpick to place the dot. Allow it to dry and superimpose successive dots on the original spot until it becomes a very dark green.

To develop the chromatogram, bend the strip so that it is at right angles with the rest of the circular paper. Add acetone to a clean 100 mL beaker until it will be below the spot but above the tip of the strip when the circular paper rests on top of the beaker. Place the paper on top of the beaker as shown in the figure. Observe what occurs as the acetone travels up the strip.

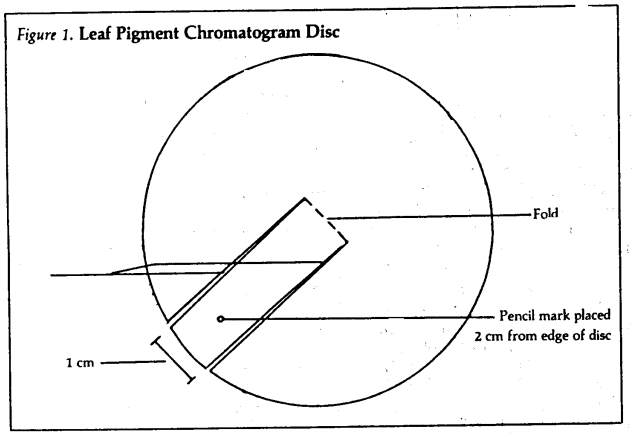


Figure 1. **Leaf Pigment Chromatogram Disc**

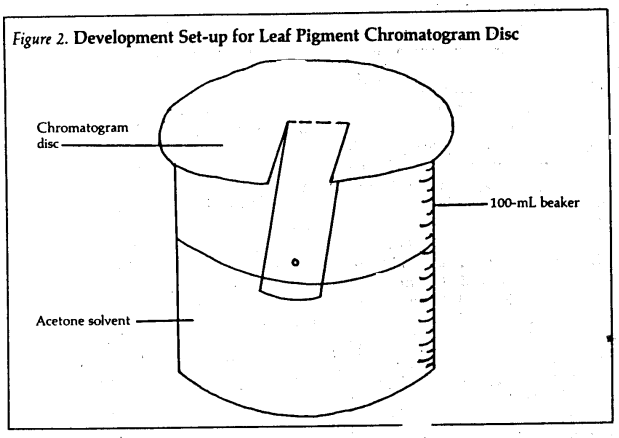


Figure 2. **Development Set-up for Leaf Pigment Chromatogram Disc**

1. Is chlorophyll one substance or a mixture of substances? Provide evidence to support your conclusion. How many substances did you find?

2. Use the results of the activity to explain what happens when leaves change colors in the fall.

3. What other mixtures could be separated using chromatography?

Student Sheet

Science as Inquiry

Melting Ice

Which salt makes the best solution for melting ice?

Overview:

Salt is sometimes thrown on roads during the winter to melt the ice. Various salts can be used. Which is the better salt to use—sodium chloride or calcium chloride? To find out, you will note the behavior of solutions of the two salts.

Procedure:

Obtain 9 mL of water in each of two test tubes. These will be used for making your solutions of each salt. You will be adding successive masses of salt to each test tube to make 10%, 20%, etc., solutions until the solutions are saturated (point where no more solid will dissolve).

Make a 10% solution of each salt by weighing out and adding the appropriate mass of salt to each. Stir until the salt dissolves and note any temperature changes that occur.

Now calculate the mass of salt needed to prepare 20%, 30%, and 40% solutions. Add the mass of salt to make a 20% solution of each salt and stir vigorously. Continue this process until the solutions become saturated (note: both may not require the same quantity of salt, and you may need to make even more concentrated solution). Record your observations.

Now place the solutions in a hot water bath and heat the water until the solutions reach about 50°C. Continue adding salt, increasing the concentration by 10% until saturated.

Now boil the solutions and note the boiling temperature.

Cool the solutions overnight by placing them in a freezer. During the next lab session, note the contents of each tube. Let the test tubes with the solutions stand in a warm room and observe.

1. Which salt would be most effective for melting ice on highways? Give reasons for your answer.

2. What other factors in addition to the freezing temperature of a salt solution must be considered when determining which salt to use on the highways.

3. Consider the other factors by doing some research outside of class and then come to some conclusion about the better salt to use.

4. Which salt solution produced the higher boiling point? Do you think that the same solution would have the lower freezing point?

5. Explain on the particle level why adding a salt to a liquid elevates the boiling point and depresses the freezing point.

6. Give other examples where solutions are made to increase the boiling point or lower the freezing point.

Science as Inquiry

Crystals from Solutions

Do all salts look the same under a microscope?

Overview:

After comparing the shapes of large and small sodium chloride crystals, you will prepare and compare crystals of other salts.

Procedure:

Observe the shape of small (table salt) and large (kosher salt) crystals of sodium chloride by placing several grains of each on a microscope slide and viewing them through a microscope. Record your observations of the shape of the crystal. Crush a piece of the kosher salt and observe again.

Prepare crystals of the salt listed below that is assigned to you by your teacher. To do this, measure 30 mL of distilled water in a beaker. Weigh the quantity of salt needed, grind if necessary with a mortar and pestle, and add to the water. Stir the solution and heat if necessary, using a ring stand and burner, to dissolve the salt.

Salt	Formula	Quantity
alum	$KAl(SO_4)_2 \cdot 12H_2O$	5g
copper sulfate	$CuSO_4 \cdot 5H_2O$	6g
potassium sulfate	K_2SO4	5g
ammonium ferric sulfate	$(NH_4Fe(SO_4)_2 \cdot 12H_2O$	40g
sodium ferrocyanide	$Na_4Fe(CN)_6 \cdot 10H_2O$	10g
magnesium sulfate	$MgSO_4$	14g

Now follow the directions of your teacher for evaporating the water from the solution. You will either let the solution cool in the beaker and evaporate it overnight, pour some into a watch glass and heat gently using the burner and ring stand, or give some to your teacher, who will place it on a microscope for the class to view.

1. Describe differences observed between the regular salt and kosher salt.

2. What did you see when you observed the crushed salt under the microscope? Explain your result in terms of the particles that make up the salt.

3. Describe the different shapes of the various salts prepared by students in your class. How can you explain the differences in terms of the particles of which they are composed?.

Student Sheet

Science as Inquiry

Separating Mixtures

What method can be used to separate different kinds of mixtures?

Overview:

Given a list of materials that form mixtures, determine the properties used to separate them and identify a method of separation. Then perform one of the separations.

Procedure:

Determine the properties of each material listed for a mixture given to you by your teacher. Then determine the method that you would use to separate them.

Select one of the mixtures (or you may be assigned one by your teacher). Write out the procedure for separating a mixture of the two materials. Get the approval of your teacher before beginning.

Make a mixture of the two materials by mixing together small quantities (about 5 mL or less) of each. Separate the mixture, being certain to have both materials present when the separation is complete.

1. Classify each of the mixtures as homogeneous and heterogeneous. Were any of the mixtures solutions?

2. How would you separate a mixture of salt and sugar?

3. How would you separate a mixture of rubbing alcohol and water?

4. Draw pictures of the particles in solid and liquid heterogeneous mixtures and solid, liquid, and gaseous solutions.

5. What are the major differences between solutions and substances on the macroscopic level? On the particle level?

Separation of Mixtures

	Mixture	Properties	Method of Separation
1.	gravel and sand		
2.	sugar and sulfur		
3.	iron and sulfur		
4.	salt and water		
5.	Kool-Aid® and water		
6.	chalk and copper sulfate		
7.	sand and copper sulfate		
8.	salt and sand		
9.	salt and iron		