EXPLORATION C2

HOLT ChemFile LAB PROGRAM

Separation of Mixtures

Objectives

Identify **chemical and physical properties of substances.**

Relate **knowledge of properties to the task of separating mixed items.**

Identify **as many methods for separating the items as possible.**

Separate **the components of a mixture.**

Analyze **success of methods for purifying mixtures.**

Design and implement **your own procedure.**

Situation

You work for a company that has joined the adopt-a-school program. The Springfield Consolidated School District is holding a Science Olympics, and your company has volunteered to prepare challenge packages containing a mixture of sand, salt, iron filings, and poppy seeds. The participants in the Science Olympics will be challenged to recover each of the components of the mixture as separate items. Your supervisor has asked you to try the challenge so that you can develop guidelines for evaluating the contestants' procedures.

Background

A mixture is a combination of two or more kinds of matter. The different kinds of matter in a mixture can be separated by physical means because each component in a mixture retains its own composition and properties. Some methods will work for some components, but not for others. Another issue to keep in mind is how easy it will be to reclaim the different components of a mixture. For example, although paper chromatography can indicate the number and colors of components in a mixture, it can be difficult to use as a method for recovering the components.

Problem

In order to prepare guidelines for evaluating the task, you must do the following.

- Identify as many physical and chemical properties of the substances in the mixture as you can.
- Figure out how to use these properties to identify as many different methods of separation as you can.
- Evaluate the methods to determine which is the best.
- Perform this method, and record the time it takes.

Safety

Always wear safety goggles and a lab apron to protect your eyes and clothing. If you get a chemical in your eyes, immediately flush the chemical out at the eyewash station while calling to your teacher. Know the locations of the emergency lab shower and eyewash station and the procedure for using them.

Do not touch any chemicals. If you get a chemical on your skin or clothing, wash the chemical off at the sink while calling to your teacher. Make sure you carefully read the labels and follow the directions on all containers of chemicals that you use. Do not taste any chemicals or items used in the laboratory. Never return leftovers to their original containers; take only small amounts to avoid wasting supplies.

Always clean up the lab and all equipment after use, and dispose of substances according to proper disposal methods. Wash your hands thoroughly before you leave the lab after all lab work is finished.

Preparation

Organizing Methods

1. Before you begin, you will need to develop a plan for separating the components of the mixture. Start by trying to determine which properties of a component in the mixture are not shared by most of the other components. When you think you know what to do, **write down the entire plan in your lab notebook before you proceed.** Be sure to estimate how long each step will take so that you can plan your time in lab more effectively.
2. If any part of your procedure involves a long period of waiting, try to reach that point before the end of the class period. Write your name on the side of your petri dish, and use it as a holding bin for your setup. Ask your teacher where you can leave it until you can complete your procedure on the next lab day.

Technique

3. Obtain a sample of the mixture, a petri dish, a microfunnel, and an 8-well microchemistry strip. Using the microfunnel, place a small part of your sample in the first well of the 8-well microchemistry strip so that you will be able to compare your separated components to the original mixture. Place a small piece of tape over the opening of the well so that the contents will not spill out.
4. Record the time when you begin your work in your lab notebook.
5. Using any or all of the items listed in the materials list, implement the procedure you wrote in your lab notebook to separate and recover all four components of the rest of the mixture. Make as many observations as possible at each step, and record exactly what you do in your lab notebook.

Materials

- 8-well microchemistry strip
- Aluminum foil
- Cellophane
- Cotton balls
- Distilled water
- Filter paper
- Forceps
- Glass funnel
- Magnets
- Microfunnel
- Paper clips
- Paper towels
- Petri dish
- Pipets
- Plastic forks
- Plastic spoons
- Plastic straws
- Rubber stoppers
- Sample of mixture
- Tape
- Test-tube holder
- Test-tube rack
- Test tubes
- Tissue paper
- Wood splints

6. When you have separated the first component from the mixture, place a small amount of it in the third well of the 8-well microchemistry strip, leaving the second well empty between the mixture in the first well and the purified component in the third well. Place a small piece of tape over the opening of the well.
7. As each component is separated, place small amounts in the fourth through sixth wells of the 8-well microchemistry strip. Place a small piece of tape over the opening of each well after it is filled, so that the contents do not spill out.
8. When all of the components have been separated, ask your teacher to inspect the samples and approve your work. If it is approved, record how long it has taken in your lab notebook. Write this on a small piece of paper. Place the paper and the 8-well microchemistry strip in your petri dish, and put them in the location indicated by your teacher.
9. Examine the strips of other lab groups. Record observations about the purity of each lab group's samples of salt, sand, iron filings, and poppy seeds. Record observations about the amount of time each lab group took.

Cleanup and Disposal

10. Your teacher should have placed several disposal containers at the front of the room. After the appropriate wells have been filled with small samples of the recovered components, place the remainder of each recovered component in the appropriate disposal containers. Clean up your equipment and lab station. Thoroughly wash your hands after completing the lab work and cleanup.

Analysis and Interpretation

1. ***Analyzing Results***
   Write a paragraph summarizing your procedure. In your estimation, rate the recovery of each component on a scale of 1–10. Justify the estimations of your success based on both the purity of your components and the time it took for you to do the job.

Conclusions

2. ***Evaluating Methods***
   What made you decide to do your procedural steps in the order that you did them? Would any order have worked?
3. ***Analyzing Methods***
   If you were able to do the lab over again, what specific things would you do differently?
4. ***Applying Ideas***
   Name any materials or tools that were not available that might have made the separation of the substances easier.
5. ***Analyzing Conclusions***
   For each of the four components, describe a specific physical property that enabled you to separate it from the rest of the mixture.

6. ***Evaluating Methods***
Discuss the relationship you expect to find between the speed of the process and the purity of the components recovered. Which do you think is more important? Explain your answer.

7. ***Evaluating Methods***
Create a plan for scoring the results of students participating in the Science Olympics. Apply this plan to the observations you made about the other lab groups' results, and provide a list of scores for your class.

Extensions

1. ***Applying Information***
What methods could you use to determine the purity of each of your recovered components?

2. ***Applying Ideas***
How would you separate each of the following two-part mixtures?
   - ***a.*** lead filings and iron filings
   - ***b.*** sand and gravel
   - ***c.*** sand and finely ground plastic foam
   - ***d.*** salt and sugar
   - ***e.*** alcohol and water
   - ***f.*** nitrogen and oxygen

3. ***Research and Communication***
Find out about methods used to produce large quantities of products from coal or oil. Prepare a chart or poster to explain the different stages of separation of these products.

4. ***Research and Communication***
Investigate the ways in which drinking water is purified in your community. Prepare a presentation to your class about how these methods work and why they must be used.

TEACHER'S NOTES
EXPLORATION C2

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Separation of Mixtures

Objectives

Students will
- use appropriate lab safety procedures.
- identify chemical and physical properties of substances.
- relate knowledge of properties to the task of separating mixtures.
- identify methods of separating the items.
- design and implement their own procedure.
- separate the components of a mixture.
- analyze the success of methods of purifying mixtures.

Planning

Recommended Time

2 lab periods (evaporation time may be necessary)

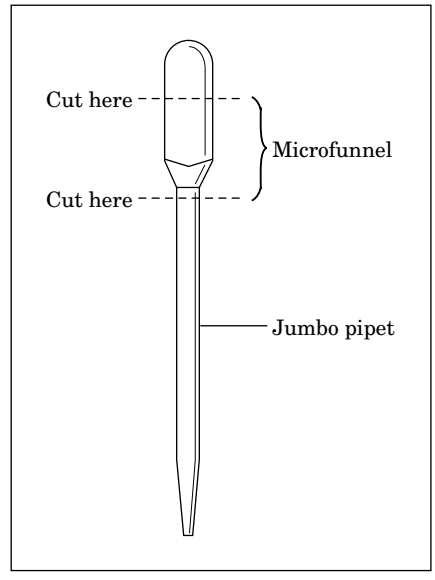
Materials

*(for each lab group)**
- 8-well microchemistry strip
- Aluminum foil
- Cellophane
- Cotton balls
- Distilled water
- Filter paper
- Forceps
- Glass funnel
- Iron filings
- Magnets
- Microfunnel
- Paper clips
- Paper towels
- Petri dish
- Pipets
- Plastic forks
- Plastic spoons
- Plastic straws
- Poppy seeds
- Rubber stoppers
- Sample of mixture, 10 g
- Salt
- Sand
- Tape
- Test-tube holder
- Test-tube rack
- Test tubes
- Tissue paper
- Wood splints

* Note that not all of this equipment is useful for separating the mixture. It is still recommended that you have all of it available so that students are required to think through what they will do.

Required Precautions

- Safety goggles and a lab apron must be worn at all times to provide protection for your eyes and clothing.
- Read all safety cautions, and discuss them with your students.



Solution/Material Preparation

1. To make a microfunnel, cut the stem and the top of the bulb off a jumbo pipet, as shown in the illustration. Students can use these funnels to fill the wells in their 8-well microchemistry strip.
2. To make the mixture, take each of the four components and mix them. About 100 g at a time can be made if 25 g of each component are poured together in a zippered, resealable plastic bag. After shaking, the mixture may be dispensed to the students in stoppered test tubes, each containing 10 g of the mixture.
3. For an additional challenge, you can provide smaller amounts of the mixture. However, students are unlikely to be successful with less than 2 g.
4. Space should be available for air-drying samples overnight.

Student Orientation

Techniques to Demonstrate

Demonstrate the filtration technique you will use. Be sure to point out common technique errors such as pouring too much mixture into a filter or misaligning the filter paper in the funnel.

Pre-Lab Discussion

Be certain students realize the importance of thinking through their procedures before they begin. Point out that once they make a mistake with their sample, it is likely to set them back even further than if they take time to think about it first.

Post-Lab

Sample Separation Procedure

(Note: students' procedures may vary.)

Spread the mixture on a paper towel. Wrap a magnet in a piece of cellophane. Pass the magnet over and through the mixture, shaking loose non-iron particles. Repeat this technique to remove as much iron as possible. Unwrap the magnet, keeping the iron inside the cellophane. The iron is now separated and recovered.

Place the sample in a petri dish. Add some distilled water. The poppy seeds should float to the top. Remove them carefully with a plastic spoon. The poppy seeds are now separated and recovered.

Stir the mixture until the salt is entirely dissolved. Fold a piece of filter paper in quarters, and place it in a glass funnel. Transfer the remaining mixture from the petri dish to the filter. Catch the filtrate with a test tube. Add small amounts of water to the petri dish and repeat until all of the sand has been washed onto the filter paper. Remove the filter paper from the funnel, and let it dry overnight. The sand is now separated and recovered.

Pour the saltwater filtrate into the petri dish. Rinse the tube with distilled water to be sure all the salt is transferred back to the petri dish. Allow the water to evaporate overnight. Then use a plastic spoon to scrape out as many salt crystals as possible. The salt is now separated and recovered.

Disposal

Put out five disposal containers for the students, for iron, poppy seeds, sand, salt, and the unseparated mixture, respectively. The materials may be reused next year, even if the students have not done a particularly good job of separation, because you will be mixing the substances again the next time the Exploration is performed.

Answers to

Analysis and Interpretation

1. Students' answers will vary. See the sample procedure above for one possible solution. As justifications for their estimations of success, they may mention the presence (or absence of) impurities in the separated components and the amount recovered or the time it took to complete the separation.

Conclusions

2. For most students, the order of the procedure will be very important. For example, if the filtration is the first step, when you are finished, you will still have the wet sand-iron-poppy-seed mixture to sort out.
3. Students' suggestions for changing the procedure will vary. Be certain that their suggestions include safe, thorough procedures.
4. Students' suggestions for additional equipment will vary. One likely suggestion is the use of a hot plate or drying oven to speed evaporation steps. Pay attention to their suggestions so that you

can add this equipment to the list the next time you have students perform this Exploration.

5. Students' identification of properties will probably vary but may include: iron is attracted by a magnet, salt dissolves in water, poppy seeds float in water, and sand sinks in water.

6. Students' answers will vary. In much of science, purity is often more important than the speed of the process, but not always. Accept either answer, provided that the reasoning for it is complete and thorough.

7. Students' suggestions for scoring will vary. A possible scoring method could be to make a determination of component's purity on a scale of 1 to 10, add the values together, and divide by the time it took to complete the procedure. Then these scores could be compared for different groups. Be certain that students apply their scoring plan to the results for the rest of the class.

Extensions

1. Students' suggestions for determining purity will vary but may include ideas such as comparing the densities of their samples to the densities of standard samples of the pure components or picking through their samples and checking for visible impurities.
2. Possible answers:
   a. Lead filings and iron filings can be separated with a magnet.
   b. Sand and gravel could be separated by a screen or sifter.
   c. Sand and finely ground plastic foam could be separated by adding water; the foam will float, and the sand will sink.
   d. Sugar will dissolve in some substances that salt will not.
   e. Because they have different boiling points, alcohol and water can be separated through distillation.
   f. Because they have different boiling points, nitrogen and oxygen can be separated through distillation.
3. Students' presentations about petroleum and coal products will vary. Be sure that students identify the stages of the process in which mixture separation techniques are used.
4. Students' presentations of the water treatment process will vary. Be sure students indicate what impurities are removed at each step.

Additional Notes