Lab: Distillation of Common Soft Drinks

FOR THE TEACHER

Summary
In this lab, students will see the distillation procedure using a common soft drink and a simple equipment setup.

Resource Type          Grade Level
Lab                      High school

Objectives
By the end of this lesson, students will
  • Understand how distillation works.
  • Separate a mixture into its components.

Chemistry Topics
This lesson supports students’ understanding of
  • Physical changes
  • Distillation
  • Separating mixtures

Time
Teacher Preparation: 15 minutes
Lesson: 30 minutes

Materials
For each group:
  • 50 mL of soda or other colored beverage
  • 400–600-mL beaker
  • 3 stoppers
  • 50-mL beaker
  • Aluminum foil
  • Ice cubes
  • Hot plate

Safety
  • Always wear safety goggles when working in a chemistry lab.
  • Do not consume lab solutions, even if they’re otherwise edible products.
  • Exercise caution when using a heat source.
  • Students should wash their hands thoroughly before leaving the lab.
  • When students complete the lab, instruct them how to clean up their materials and dispose of any chemicals.
Teacher Notes
- While commonly used, the concept of distillation is problematic for students because they generally cannot visualize the process or have it demonstrated with the specialized equipment that is required.
- This apparatus uses common laboratory equipment that should be available in every first-year chemistry laboratory and a couple of household items.
- I chose the original Texas soft drink, Dr Pepper, but any colored cola-type drink or a colored juice like orange juice is appropriate.
- Physical separation techniques are a common topic in first-year chemistry courses. Most students are familiar with the techniques of magnetic separation, filtration, vaporization, and paper chromatography. However, few students have the opportunity to experiment with distillation until completing organic chemistry labs. The distillation process can also be in the discussion of states of matter and the changes that occur when a liquid is heated and reaches the boiling point.
- A Bunsen burner can be used instead of a hot plate. However, the hot plate does allow for a portion of the distillation process to continue while the residual heat dissipates.
- If smart phones or other devices are available, pictures of the apparatus before heating and after the distillation has concluded may be taken in order to compare colors.
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For the Student

Lesson
Background
The simple distillation process was first recorded in India and China around 800 B.C.; it was used in the production of beer and rice wine. Beer distilling in France began in the 16th century and whiskey in Ireland in the 17th century. The petroleum industry uses distillation extensively to refine crude oil into many usable products such as gasoline, heating oil, chemical feed stocks, and paraffin wax. The distillation process is commonly used to purify liquids and separate mixtures.

Prelab Questions
1. Define boiling point.
2. Define distillation.
3. Define distillate.
4. Compare and contrast homogeneous and heterogeneous mixtures.
5. Compare and contrast physical and chemical changes.
6. Illustrate the particles in the beaker before the distillation process begins. Use a key to indicate symbols to represent parts of the solution.

Procedure
1. Pour approximately 50 mL of Dr Pepper into a 400–600-mL beaker. This should be enough to cover the bottom of the beaker to a depth of about 1 cm. Record the exact volume and observations of the liquid.
2. Place one to three rubber stoppers in the bottom of the beaker with the large end down. Place an empty 50-mL beaker on the stoppers. The beaker should not wobble.
3. Cover the mouth of the large beaker with aluminum foil that has been formed
into a cone with the depression point in the middle of the foil targeting the small beaker. That is, the tip of the aluminum cone should be directly over the 50-mL beaker.

4. Place this apparatus carefully onto an electric hot plate and heat until the liquid boils. Place three or four ice cubes (or a handful of crushed ice) in the depression to cool the aluminum foil and begin heating.

5. Turn the hot plate off once the ice has melted. Allow the apparatus to cool (about 5 minutes).

6. Measure the volume of the liquid collected in the small beaker. Make observations of the collected liquid.

**Analysis**

1. Describe the volume of the liquid in the larger beaker after the distillation process to the original volume of that liquid.

2. Is distillation a physical or chemical separation process? Use your data to support your answer.

3. Compare and contrast the liquids in the beakers.

4. Calculate the percentage by volume of water that you extracted from your sample.

5. Illustrate the particles in both beakers after the distillation process. Use the same key you used in the prelab questions to represent the parts of the solution.

**Connections to Standards**

**Next Generation Science Standards**

HS-PS1-3: Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale along with Science and Engineering Practice of developing a model based on evidence to illustrate the relationships between systems or between components of a system.