Techniques for Separating Mixtures - Chemistry, Grade 9-10

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Lesson Plan Summary: In this lesson plan, students will measure and calculate the density of a variety of elements and compounds. Students will also be able to describe and explain techniques such as filtering, evaporation, decantation, chromatography and distillation.

Time to Complete: 2 hours (2 classes of 60 min)

Content Objectives:

The student is expected to:

- Relate the chemical behavior of an element including bonding, to its placement on the periodic table. **TEKS §112.42. Integrated Physics and Chemistry.(c)(7)(D).**
- Compare and contrast the concepts of pure substances and mixture.
- Review concepts of element, compound, pure substance, mixture.
- Classify samples of matter from everyday life as being elements, compounds, or mixtures. **TEKS §112.42. Integrated Physics and Chemistry.(c)(7)(E).**
- Define the types of mixtures.
- Mention physical and chemical properties.
- List techniques of separation for mixtures.
- Investigate and identify properties of fluids including density, viscosity, and buoyancy; **TEKS §112.42. Integrated Physics and Chemistry.(c)(7)(A).**

Class Procedure for building background

1. Use a copy of the Periodic Table to help explain the concept of an element to the class, including how elements are grouped in relation to patterns of physical and chemical properties, examples of physical and chemical properties, and the use of chemical symbols.
2. Define "compound," using the example of water and carbon dioxide to show their formulas and stating that reactions between elements produce compounds. Highlight the fact that the elements are joined by chemical bonding and state the laws of definite proportions and conservation of mass.
3. Define pure substance and explain that elements and compounds are the pure substances. Ask the students: Is everything around us a pure substance?
4. Guide the students to give examples of mixtures.
5. Define mixture and contrast it with a compound. Conclude that a mixture may be separated by techniques such as filtering, chromatography, evaporation, and distillation.
6. Guide the students to identify the physical property involved in each technique.
7. Ask the student what the difference is between a mixture of water and salt and a mixture of water and oil (demonstrate each one in the laboratory).
8. Help the students define homogeneous and heterogeneous mixtures.
9. Ask them how each type of mixture might be separated.
10. Ask the students to contrast the physical properties of density, viscosity, and buoyancy.
11. State some values of density.

12. Compare the viscosity of water, oil and syrup.
13. Outline the materials required for distillation: a container for the original mixture, a condenser to cool the vapor and a receiver to collect the distillate.
14. Emphasize the contrast of distilling wine and beer with the traditional distillation process used in Mexico for mescal. Use the TIDES images for "Distilling industries."

Vocabulary

Element; compound; pure substances; mixtures; homogeneous mixture; heterogeneous mixture; chemical properties; physical properties; density; viscosity; and buoyancy.

Hands on Activities

Laboratory practice – Demonstration # 1 Density

Students will evaluate the density of liquids and compare their lab values with those reported in the literature. Students will use the Data Table on the Calculating Density worksheet to record their findings, analysis and conclusions.

Materials

Images of Distilling Industry in Mezcal

- http://tides.sfasu.edu:2006/cdm4/item_viewer.php?CISOROOT=/Digital&CISOPTR=2642&CISOBOX=1&REC=14.
- http://tides.sfasu.edu:2006/cdm4/item_viewer.php?CISOROOT=/Digital&CISOPTR=2637&CISOBOX=1&REC=9
- http://tides.sfasu.edu:2006/cdm4/item_viewer.php?CISOROOT=/Digital&CISOPTR=2653&CISOBOX=1&REC=3
- http://tides.sfasu.edu:2006/cdm4/item_viewer.php?CISOROOT=/Digital&CISOPTR=2629&CISOBOX=1&REC=1
- http://tides.sfasu.edu:2006/cdm4/item_viewer.php?CISOROOT=/Digital&CISOPTR=2609&CISOBOX=1&REC=13
- http://tides.sfasu.edu:2006/cdm4/item_viewer.php?CISOROOT=/Digital&CISOPTR=2605&CISOBOX=1&REC=16
- Work sheet to record values

- Graduated cylinder (50 ml)
- Scale
- Vegetable oil (corn D= 0. 922 g/ml or olive D= 0. 918 g/ml)
- Glycerine (D= 1.26 g/ml)
- Distillated Water (D= 1 g/ml)
- 3 beakers (10 ml)
- 3 pipettes
- 1-3 g samples of the following metals:
  - Aluminum sample (foil may be used) (D= 2.70 g/ml)
  - Copper sample (wire may be used) (D= 8.96 g/ml)
  - Iron sample (a nail may be used) (D= 7.87 g/ml)

Procedure

1. Weigh each metal sample separately and record each weight.
2. Add 20 ml of water to the graduated cylinder
3. Place the sample of iron inside the graduated cylinder
4. Carefully observe the value change in the cylinder
5. Record the difference in ml, i.e.: if it increased from 20 ml to 22.5 ml when you introduce the iron sample, record 2.5 ml in the data table.
6. Remove the iron sample.
7. Repeat step 1-6 with the aluminum sample.
8. Repeat steps 1-6 with the copper sample.
9. Label each beaker with numbers 1 through 3.
10. Weigh each empty beaker and record this weight in the data table.
11. Add 10 ml of water to beaker number 1.
12. Weigh beaker number 1 with water and record its value.
13. Add 10 ml of glycerin to beaker number 2.
14. Weigh beaker number 2 with glycerin and record its value.
15. Add 10 ml of corn oil to beaker number 3.
16. Weigh beaker number 3 with oil and record its value.
17. Calculate each density value using the formula: D= mass (g) / volume (ml)
18. Compare your values with those found in the literature.

Laboratory practice - Demonstration # 2 Separating mixtures
Students will draw, describe and explain the physical property illustrated by each technique. Students will demonstrate and explain the uses of each of the following techniques:

1. **Filtering** (use the heterogeneous mixture of sand and water and separate it with a coffee filter)
2. **Evaporation** (use the homogeneous mixture of salt and water and boil the water away with the Bunsen burner)
3. **Decantation** (use heterogeneous mixture of sand and water and separate them using density – carefully pour a solution from a container, leaving the precipitate [sediments] in the bottom of the container)
4. **Chromatography** (use filter paper marked with dots and place them with ethylic alcohol)
5. **Distillation** (use water with ethanol and the distillation batch with the condenser, a distilling flask, column, hot plate and thermometer).

Assessment
Homework 1: Create a list of 10 elements, 10 compounds and 10 mixtures (5 homogeneous and 5 heterogeneous), all of which should be found in the environment around you.

Homework 2: Investigate the concepts and example of the fluids properties: density, viscosity, and buoyancy

CALCULATING DENSITY

Introduction

Density is a physical property of matter. Each element and compound has a unique density associated with it. Density is the weight of something as compared to its size. This relative "heaviness" may be calculated using the formula of Density = mass (g) / volume (ml).
D = m / V

Pre-lab questions

1. What is density?
2. Why don't oil and water mix?
3. Why does oil always rise in water?
4. From the following list of elements and compounds choose which you think is the most dense and which is the least: aluminum, iron, cooper, water, oil, and glycerin.

Objective:

You will measure the density of aluminum, iron, cooper, water, glycerin and vegetable oil

Hypothesis

Explain what you might expect each of the densities to be and why.

Materials

- Graduated cylinder (50 ml)
- Scale
- Vegetable oil (corn D= 0. 922 g/ml or olive D= 0. 918 g/ml)
- Glycerin (D= 1.26 g/ml)
- Distillated Water (D= 1 g/ml)
- 3 beakers (10 ml)
- 3 pipettes
- 1-3 g samples of the following metals:
    - Aluminum sample (foil may be used) (D= 2.70 g/ml)
    - Cooper sample (wire may be used) (D= 8.96 g/ml)
    - Iron sample (a nail may be used) (D= 7.87 g/ml)
- Work sheet to record values

Procedure

1. Weigh each metal sample separately and record each weight.
2. Add 20 ml of water to the graduated cylinder
3. Place the sample of iron inside the graduated cylinder
4. Carefully observe the value change in the cylinder
5. Record the difference in ml, i.e.: if it increased from 20 ml to 22.5 ml when you introduce the iron sample, record 2.5 ml in the data table.

6. Remove the iron sample.
7. Repeat step 1-6 with the aluminum sample.
8. Repeat steps 1-6 with the copper sample.
9. Label each beaker with numbers 1 through 3.
10. Weigh each empty beaker and record this weight in the data table.
11. Add 10 ml of water to beaker number 1.
12. Weigh beaker number 1 with water and record its value.
13. Add 10 ml of glycerin to beaker number 2.
14. Weigh beaker number 2 with glycerin and record its value.
15. Add 10 ml of corn oil to beaker number 3.
16. Weigh beaker number 3 with oil and record its value.
17. Calculate each density value using the formula: D= mass (g) / volume (ml)
18. Compare your values with those found in the literature.

Data Table

Density for metals				
Sample	**Mass (g)**	**Volume difference (ml)**	**Density lab value D=m/V**	**Real Density value**
Iron				
Aluminum				
Cooper				

Sample	**Mass (g)**
Empty beaker 1	
Beaker 1 with water	
Water net value	
Empty beaker 2	
Beaker 2 with glycerin	
Glycerin net value	
Empty beaker 3	
Beaker 3 with vegetable oil	
Vegetable oil net value	

Density for liquids				
Sample	**Net Mass (g)**	**Volume (ml)**	**Density lab value D=m/V**	**Real Density value**
Water				
Glycerin				
Vegetable oil				

Data Analysis and conclusions

1. Did the lab values correspond to the real or reported values? Why?

2. Did your hypothesis correspond to the results? Explain

3. According to density concept, why is it easier to float in the sea than in a swimming pool?