SUSTAINABLE BIOECONOMY
FOR ARID REGIONS

SEPARATION OF A MIXTURE ACTIVITY PLAN

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ABSTRACT

The physical properties of matter are useful to separate molecules from each other. In this activity, students develop a method to separate a mixture of four substances with different physical properties and calculate each substance's percent recovery after separation. Students are introduced to guar and guayule – two crops that produce plant compounds (mixtures) essential to the food, pharmaceutical, and tire industries. Students are also introduced to the technology used to separate important compounds from guar and guayule.

Laura Rodriguez-Uribe NMSU-SBAR Research and Education Specialist

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SEPARATION OF A MIXTURE

STUDENT LEARNING OBJECTIVES:

After completing these activities, the students will:

1. Explain and define a mixture
2. List and describe a few methods for separation of components in a mixture using the physical properties of each component
3. List a few plant chemicals important to humans
4. Design a method to separate a mixture
5. Use an equation to calculate the percent recovery of each component following separation
6. Name conventional methods for separation of substances

TIME REQUIRED:

60 minutes
20 min teacher preparation

RESOURCES:

1. Separation of a Mixture PowerPoint

EQUIPMENT AND SUPPLIES NEEDED:

1. A copy of the Activity Worksheet Parts 1-3 (pages 7- 9 of this activity) per team of 3-4 students
2. Iron (Fe) filings – 3g/team
3. Salt (NaCl) – 3g/team
4. Sand (SiO_2) – 5g/team
5. Guar seeds – 1g/team
6. Electronic balance – 1/team
7. Hot plate – 1/team
8. Porcelain evaporating dish – 1/team
9. 50ml Beakers – 2/team
10. Wash bottle with distilled water
11. Filter funnel – 1/team
12. Filter paper – 3/team
13. Magnet – 1/team
14. Ziploc bag – 1/team

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15. Ring stand and ring – 1/team
16. Plastic teaspoons – 4/team
17. Plastic tubes – 10/team
18. Weighing boats – 8/team
19. Tweezers – 1pair/team
20. Hot vessel gripping device – 1/team
21. Gloves – 1 pair/student
22. Safety glasses/goggles – 1 pair/student
23. Paper towels – 10 sheets/team
24. Pencils – 1/student
25. White paper for notes – 3 pages/team
26. Computer with internet – 1/classroom
27. Internet connection

THIS ACTIVITY PLAN WOULD WORK WELL AS PART OF:

- Chemistry lesson
- Plant biology lesson

THESE ACTIVITIES ARE ALIGNED TO THE FOLLOWING STANDARDS:

FFA Precept

- FFA.PL-A. Action: Assume responsibility and take the necessary steps to achieve the desired results, no matter what the goal or task at hand.
- FFA.PL-E. Awareness: Understand personal vision, mission and goals.
- FFA.PL-F. Continuous Improvement: Accept responsibility for learning and personal growth.
- FFA.PG-J. Mental Growth: Embrace cognitive and intellectual development relative to reasoning, thinking, and coping.
- FFA.CS-M. Communication: Effectively interact with others in personal and professional settings.
- FFA.CS-N. Decision Making: Analyze a situation and execute an appropriate course of action.

Common Core – Speaking and Listening

- CCSS.ELA-Literacy. SL.9-10.1: Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9-10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
- CCSS.ELA-Literacy. SL.9-10.2: Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source.

Common Core – Science and Technical Subjects

- CCSS.ELA-Literacy.RST.9-10.4: Determine the meaning of symbols, key terms, and other domain specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.

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- CCSS.ELA-Literacy.RST.9-10.7: Translate quantitative or technical information expressed in words in a text into a visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
- CCSS.ELA-Literacy.RST.9-10.9: By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently.

Common Core – Math Practices

- MP1: Make sense of problems and persevere in solving them.
- MP2: Reason abstractly and quantitatively.
- MP5: Use appropriate tools strategically.
- MP6: Attend to precision.

AFNR Career Ready Practices

- CRP.02: Apply appropriate academic and technical skills. Career-ready individuals readily access and use the knowledge and skills acquired through experience and education to be more productive.
- CRP.04: Communicate clearly, effectively, and with reason. Career-ready individuals communicate thoughts, ideas and action plans with clarity, whether using written, verbal and/or visual methods.
- CRP.06: Demonstrate creativity and innovation. Career-ready individuals regularly think of ideas that solve problems in new and different ways, and they contribute those ideas in a useful and productive manner to improve their organization.
- CRP.08: Utilize critical thinking to make sense of problems and persevere in solving them. Career-ready individuals readily recognize problems in the workplace, understand the nature of the problem, and devise effective plans to solve the problem.

Partnership for 21st Century Skills

- Critical Thinking and Problem Solving
- Flexibility and Adaptability
- Initiative and Self-Direction
- Leadership and Responsibility

ACTIVITY PLAN:

1. *Bell Ringer:*

   On your paper answer the following questions:

   - What is a mixture?
   - What plant chemicals are made in guar and guayule and why should we care about these plants?

2. *Introduction:*

   In nature, matter occurs as a pure substance or as a mixture. A mixture is a combination of substances where each substance keeps its unique physical properties. These physical properties can be used to separate the mixture into individual substances. Today, you will learn about some methods useful in the separation of components in a mixture based on the physical properties of each component. You will be provided with four different substances to make a mixture. You will then come up with a method to separate each substance from the mixture. You will use an equation

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to calculate the percent recovery of each substance after separation. Today, you will learn about guar and guayule – two crops that produce plant chemicals with nutritional benefits that are important for the food, pharmaceutical and tire industries. You will also learn about the technology used to separate plant chemicals from these plants.

3. *Activity:*

PART 1. Separation of a Mixture PowerPoint

Provide each student with a copy of the ACTIVITY WORKSHEET (page 7) and ask them to answer questions on Part 1 while watching the PowerPoint presentation.

PART 2. Student Teams and General Observations

Separate the students into teams of 3-4 students each. Assign each team to a bench with the materials for this activity, and let them know that they can use any of the materials provided to develop their separation method. Provide paper to take notes.

Ask students to follow these directions:

1) Identify each of the substances provided (salt, sand, guar seeds, and iron filings).
2) Observe the physical appearance of each; record observations on note paper.

PART 3. Preparing the Mixture

Have students work in their assigned teams to prepare a mixture for examination.
Continue following these directions:

3) Transfer one teaspoon of each sample (salt, sand, guar seeds, and iron filings) to four separate plastic weighing boats. *Hint: Be sure to use different transfer devices with each sample to prevent contamination*.
4) Observe the physical appearance of the samples. Did their appearance change? Record observations on note paper.
5) Place an empty weighing boat on the electronic balance and tare.
6) Add a teaspoon of the sand to the weighing boat. Record the mass.
7) Zero the balance (tare) and add a teaspoon of iron filings to the same weighing boat containing the sand. Record the mass.
8) Tare the balance again and add a teaspoon of guar seeds to the same weighing boat to create a mixture.
9) Calculate the percent composition of each component of the mixture using the following equation:

   percent mass = mass of component/total mass of mixture *100%

PART 4. Separation of the Mixture

Have students continue working in their assigned teams as they devise a way to separate the mixture they created in PART 3.
Continue following these directions:

10) As a team, discuss your observations on the physical properties of the salt, sand, guar seeds, and iron filings as you transferred them into the weighing boats.

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11) Use the materials available on your bench to design a method to separate the mixture from PART 3 back into the individual components. There may be multiple methods for completing this step. As a team, discuss and decide on the "best method" to use.
12) Separate the components of the mixture with your agreed upon method.
13) When you are finished with the separation, weigh and record the mass of each component. *Hint: Any container or filter paper that you use to capture individual components on/in should be weighed prior to use*.
14) Calculate the percent recovery of each component using the following equation: *percent mass* = mass of component/total mass of mixture *100%
15) Ask the students to complete sections 2 and 3 of the ACTIVITY WORKSHEET (pages 8-9).

4. *Follow-up:*

Have students describe two methods to separate salt from water. Ask the students to discuss the differences between homogeneous and heterogeneous mixtures. **Take this time to describe examples of common methods to separate and analyze compounds from guar and guayule.** This information is included in the *Separation of a Mixture PowerPoint*.

5. *Leveling Up:*

Have students find out what plant chemicals have health benefits for humans, and talk through how they can be separated from the mixtures.

6. *Exit Ticket:*

Why are plants important for humans? What kind of compounds are obtained from plants as mixtures?

DEFINITIONS:

Physical properties: The physical properties of a compound are visible and measurable. Some examples of physical properties are appearance, texture, size, smell, color, solubility, density, and polarity.
Guar: A legume that produces guar gum, which is used as a food agent for thickening, stabilizing, and binding.
Guayule: A flowering shrub native to the southwestern United States and northern Mexico. It produces rubber, latex, and resin. This plant has been used for latex and rubber production at a commercial scale.
Miscible: Substances capable of mixing, such as water and alcohol.
Immiscible: Substances incapable of mixing, such as water and oil.

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ACTIVITY WORKSHEET

Name:

Part 1

DIRECTIONS:

Choose the correct answer:

A solution can be formed when two or more liquids are mixed together

a. True
b. False

The property of water than can be used to separate salt and water in a solution is:

a. Magnetism
b. Density
c. Evaporation
d. Color

What kind of mixture can be separated by filtration?

a. Oil and water
b. Iron filings and water
c. Salt and water
d. All of the above

Choose the Physical Properties of each substance in the table below

Substance	**Magnetism**	**Solubility in Water**
Iron fillings		
Salt		
Ethanol		

Write down the percent recovery you calculated with the formula: ***percent mass* = mass of component/total mass of mixture *100%*** for the below components recovered from the mixture.

a. Iron fillings _____
b. Salt _____
c. Sand_____

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ACTIVITY WORKSHEET

Name:

Part 2

DIRECTIONS:

Read and answer the questions below:

Which of the substances in the mixture was the hardest to separate?

Why?

Which of the substances in the mixture was the easiest to separate?

Why?

Provide two examples of mixtures in nature.

Name the two crops included in this activity.

Which of these crops is a legume?

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ACTIVITY WORKSHEET

Name:

Part 3

DIRECTIONS:

Describe your method for separating the mixture's components below:

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KEY

Alignment to the following standards:
FFA.PL-A; FFA.PL-E; FFA.PL-F; FFA.PG-J; FFA.CS-M; FFA.CS-N; CCSS.ELA.SL.9-10.1; CCSS. ELA.SL.9-10.2; CCSS.ELA.RST.9-10.4; CCSS.ELA.9-10.7; CCSS.ELA.RST.9-10.9; MP1; MP2; MP5; MP6; CRP.02; CRP.04; CRP.06; CRP.08

PART 1

A solution can be formed when two or more liquids are mixed together.

a. True

The property of water that can be used to separate salt and water in a solution is:

c. Evaporation

What kind of mixture can be separated by filtration?

b. Iron filings and water

Choose the Physical Properties of each substance in the table below:

Substance	Magnetism	Solubility in Water
Iron filings	**X**	
Salt		**X**
Ethanol		**X**

PART 2

Provide two examples of mixtures in nature:
pigments, carbohydrates, nucleic acids

Name the two crops included in this lesson.
Guar and Guayule

Which of these crops is a legume?
Guar

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AUTHOR BIOGRAPHY

Laura Rodriguez-Uribe received a B.S in Biology from Universidad Autónoma del Estado de Morelos, Mexico. She received an M.S. in Biology and a Ph.D. in Molecular Biology from New Mexico State University. Before moving to NMSU, she worked for ten years at the Nitrogen Fixation Research Center and the Biotechnology Institute from the National Autonomous University of Mexico (UNAM) Cuernavaca, Mexico. Dr. Rodriguez-Uribe possesses more than thirty years of research experience, her research interests include plant molecular response to biotic and abiotic stresses, secondary plant metabolism, plant biotechnology, plant bioactive compounds, medicinal plants' chemistry, plant nutraceuticals, and functional foods development. She joined the SBAR team in October 2018 as a Research and Education Specialist and has worked with the Characterization & Co-Products and the SBAR Youth Development and Education/Extension & Outreach teams, developing curriculum with STEM-related activities for youth.

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