ROI

INDIANA UPLANDS | PROUD PARTNER

Grade 3-5 STEM Challenge

Operation Separation

Inspired by Dathan, a Biomedical Manufacturing Operator in the Indiana Uplands.

Published by Regional Opportunity Initiatives

GRADE 3-5 STEM CHALLENGE

Operation Separation

Inspired by Dathan, a Biomedical Manufacturing Operator in the Indiana Uplands.

Students will use physical properties to separate substances and discover the difference between mixtures and solutions.

CAREER CONNECTION AND LESSON OVERVIEW

Dathan is a biomedical manufacturing operator at Catalent in Bloomington, Indiana. He works in a lab where he grows cell cultures that are modified to produce vaccines and medications. Once there are enough cells to move into production, Dathan isolates the needed proteins, performs testing and collects data to make sure that the substance will be pure enough to be approved for further testing and use.

Scientists like Dathan have to be able to separate the life-saving medications they make from impurities and contaminants. In this activity, students devise ways to seaparate the components of different mixtures.

LESSON TIMELINE

DAY 1 60 minutes

- Show the inspiration video,
- "Dathan - Drug Substance Operator"
- Mixtures and Mass Predictions

DAY 2 60 minutes

- Separation Procedure Challenge

DAY 3 60 Minutes

- Results Analysis
- Solution Separation
- Observations at 24 and 48 hours

Recommended Supplies

Day 1:

- Iron filings
- Sand
- Rice
- Balance
- Hand Lens
- Variety of filters and separation tools. For example:
  - Variety of mesh screen sizes
  - Bar/Horseshoe magnets
  - Plastic Bags
  - Straws
  - Cups
  - Funnels
  - Coffee Filters

Day 2

- Salt
- Small plastic cups (1 per group)
- Petri dishes or similar small, shallow dishes.

IN THIS CHALLENGE, STUDENTS WILL:

- Design a procedure to separate a mixture.
- Observe evaporation as a technique for separating the components of a solution.
- Create a presentation about what they have learned about mixtures and solutions.

Standards

Science & Engineering Process Standards

SEPS.1 Posing Questions (for science) and defining problems (for engineering)
SEPS.2 Developing and using models and tools
SEPS.3 Constructing and performing investigations
SEPS.6 Constructing explanations (for science) and designing solutions (for engineering)
SEPS.8 Obtaining, evaluating, and communicating information

Computer Science Standards

3-5.NC.2 Use productivity technology tools for individual and collaborative writing, communication and publishing activities.

Science Standards

5.PS.1 Describe and measure the volume and mass of a sample of a given material.
5.PS.2 Demonstrate that regardless of how parts of an object are assembled the mass of the whole object is identical to the sum of the mass of the parts; however, the volume can differ from the sum of the volumes. (Law of Conservation of Mass)

Engineering Standards

3-5.E.3 Construct and perform fair investigations in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Employability Skills Standards

3-5.WE.4 Complete tasks or activities with prompting and guidance from adult educators.
3-5.WE.5 Demonstrate perseverance to complete tasks and activities.
3-5.LS.2 Communicate with others by applying a variety of speaking skills.
3-5.LS.3 Communicate with others using a variety of technology.
3-5.LS.4 Relate personal interests, abilities, and leisure time activities to possible occupational choices without stereotyping.
3-5.LS.8 Develop criteria for making decisions and predict results of choices to find the best solution.
3-5.LS.10 Identify a short-term goal and develop a plan of action.
3-5.LS.13 Utilize effective questioning and brainstorming techniques.

Regional Opportunity Initiatives, © 2021, V1
www.regionalopportunityinc.org/uplands-careers

Planning and Implementation

OPERATION SEPARATION

Essential Vocabulary

- MIXTURE: A combination of two or more different substances. The components in a mixture are not chemically joined; they are just mixed. Mixtures can be separated using physical methods.
- MASS: The amount of matter in an object. Mass is usually measured in grams (g) or kilograms (kg).
- PHYSICAL PROPERTY: A property that can be observed or measured without changing the substance. Some common physical properties include color, weight, size, and texture.
- SOLUTION: A special type of mixture in which one substance (a solute) is dissolved in another substance (a solvent).

In this challenge, students will:

- View the job shadow video Dathan - Biomedical Manufacturing Operator available at http://www.regionalopportunityinc.org/dathan/
- Design a procedure to separate a mixture
- Observe evaporation as a technique to separate a solution
- Create a presentation about what they have learned about mixtures and solutions

Day 1

Introduction (20 minutes)

Introduce the career of biomedical manufacturing operator in the field of life sciences to the students. If necessary, define the parts of these terms and discuss what kind of studies or experiments might concern the "life sciences."

Pose the question to students:

"What do you think of when you hear the word 'biomedical?"

or

"What do you think a biomedical manufacturing operator does?"

Record student responses on the board or on chart paper for the class.

Introduce Dathan's job shadow video and provide each student (or project) Dathan's career profile sheet.

> *"The person in the video we will watch today is a biomedical manufacturing operator. He works for a company that manufactures substances used for medicines and vaccines that people need. Dathan uses his knowledge of biology and chemistry to separate out the specific parts of cells that produce the ingredients needed for the substance he is making."*

Show Dathan - Biomedical Manufacturing Operator (3:11), available at http://www.regionalopportunityinc.org/dathan/. Reflect by asking students what they think is interesting about Dathan's job and if they have any questions about his job.

Introduce the Challenge

Explain that they will begin the study of Dathan's job by exploring different substances, their properties, and then use the engineering design process to determine a way to separate them when combined into a mixture.

> *"You heard in the video that an important part of Dathan's job is to isolate the protein that cells make and grow more of it to be used in medicines.*

> *"In Days 1 and 2, you will discover some ways in which biomedical professionals and scientists separate and isolate particular parts of a mixture by designing and testing your own separation technique.*

> *"On Day 3, you will create a kind of mixture called a solution in which one substance is dissolved into another. You will then observe the isolation of one of the substances using evaporation."*

Ask and Imagine (20 minutes)

Students will work in pairs for this activity. Pose to students the guiding question:

"How could we separate and isolate the three substances in a mixture?

Prepare students for the investigation by orienting them to the substances and tools they will be using. Before passing out materials, explain each substance and the available tools to the students.

> *For older students: it may be appropriate to introduce only the substances in order to challenge them to explore and choose their own tools.*

Explain that they will be observing and recording the physical properties of these substances and what they notice about them on their student handout BEFORE mixing them together. To help them design a strategy to separate the sand, rice, and iron filings, students should first become familiar with the physical properties of each of the three substances. Physical properties they will likely observe are size of particles, texture, and color. Using the available materials to further explore the substances, students may also observe other properties, like magnetism. Prompt students to notice what is different about the substances and think about how they might separate out one substance at a time.

- Tip: if students plan to put a magnet into the mixture to attract iron filings, prompt them to wrap the magnet in a plastic bag. Once iron filings are attached to the bag and moved to the desired location, remove the magnet from the bag to release the filings.
- Optional Extension: Students may use a balance to measure the mass of each substance prior to mixing them together. Students will repeat this measurement after separating the substances to compare. This extension addresses 5th grade science standard 5.PS.1.

Students should record their observations of the materials in the IMAGINE section of the STUDENT INVESTIGATION SHEET. Once students have recorded their observations, instruct them to combine their substances into one container and mix thoroughly.

Plan (20 minutes)

Working with their partner, students will design a method for separating the newly formed mixture back into its original three substances. Teams should complete the PLAN section of their student handout and outline a step by step strategy for how they will deconstruct their mixture. This will complete day 1.

Day 2

Create and Test (30 minutes)

Reframe the day and remind student teams that they will be testing the separation method that they designed on Day 1. Students should get their mixture from where they stored them the previous day and test their separation method. When the attempted separation is complete, students will compare the individual substances to their observations of the same substances from Day 1 to gauge the effectiveness of their method. Students will complete the CREATE & TEST section of the student handout based on their findings.

Improve and Test (30 minutes)

Challenge students to reflect on their separation strategy and to edit the method their group designed to improve it (cleaner separation, faster or easier separation, etc.) Students will first complete the first 2 questions in the IMPROVE & TEST section of the student handout. Ask students to:

- Explain the changes that their group made to the strategy. Ask:
  "Why did your group make these changes?"
- Students will then test their improved method.
  "Try your new separation strategy! Is it better? Easier? How so?"

Lastly, ask students to reflect on this trial by completing the last question in the IMPROVE & TEST section of the student handout.

Day 3

Separate a Solution Lab (30 minutes)

Students may remain in groups of two for this lab activity. Introduce the lab by reminding the students that a mixture is a combination of two or more different substances and that the components in a mixture are not chemically joined. A solution is a different kind of mixture than what the students worked with in Days 1 and 2. Specifically, a solution is a special type of mixture, usually liquid, in which one substance (called a solute) is dissolved in another substance (we call this the solvent).

To explore the differences in these types of mixtures, show Science Crash Course Kids: The Great Picnic Mix Up, available via YouTube.

> *Note: This video goes into more detail than is necessary for this lab. The goal is for students to understand the difference between a mixture and a solution.*

Explain that there are many techniques that scientists use to separate substances. The ways that they used in days 1 and 2 were likely magnetic separation and sifting (or sieving). Evaporation is another technique that scientists use to separate a substance that has been dissolved in another substance.

Pass out the lab materials to students. Each group should have:

- 1 teaspoon of salt
- 4 teaspoons (20 mL) of water
- small cup for mixing
- a small shallow dish

Students will observe the physical properties of the salt and the water and then record those observations in the Separate a Solution Lab section of the student handout. Instruct students to add water to the salt in a small cup and to swirl the cup until the salt is dissolved into the water.

Students will observe and record the physical properties of the new solution on the student handout.

Students will then pour the solution into a shallow container like a petri dish or yogurt container lid and set aside. Over the next two days students will observe and record the changes they see over time as the water evaporates and leaves the salt behind in the dish. Prompt students to observe their dish after 24 and 48 hours to see how the salt and water have separated.

Communicate (30 minutes)

Students will work with their partner to complete the COMMUNICATE section of their student handout. Have students use available technology to create a presentation summarizing what they have learned.

Presentations should include:

- a summary of the PLAN, CREATE, and IMPROVE sections of their handout
- a summary of why they think a job like Dathan's is important

Career Exploration and Extension

Prompt students to think about and research what a career as a biomedical manufacturer or researcher might entail.

- What does a biomedical manufacturing operator do all day? What does Dathan do?
- What kind of training would a student need to manufacture biomedical products? What kind of training would they need to become a scientist who makes sure substances are pure and safe?

Name: _____

Operation Separation

Student Investigation Sheet

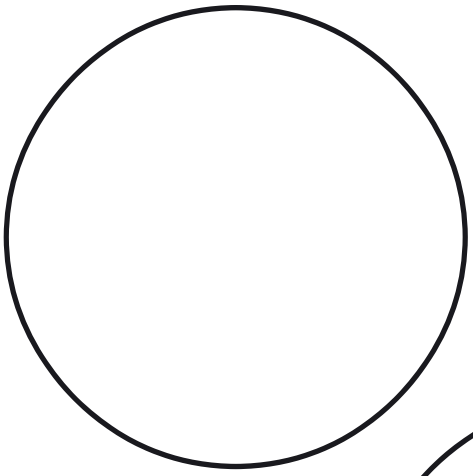
ASK
What is the problem we are going to solve?

How could we separate and isolate the three substances in a mixture?

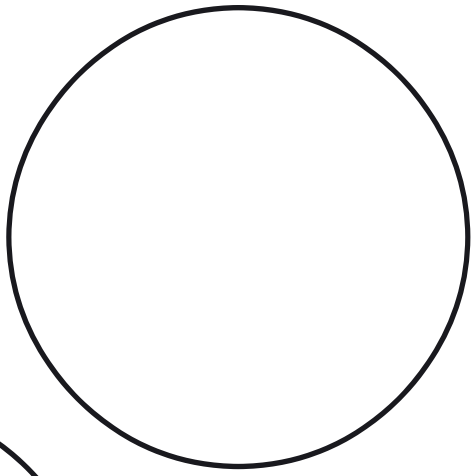
IMAGINE
What do you see?

Observe and record the physical properties of each substance. Explore the tools provided. What do you notice? What might you use to separate each substance from the other?

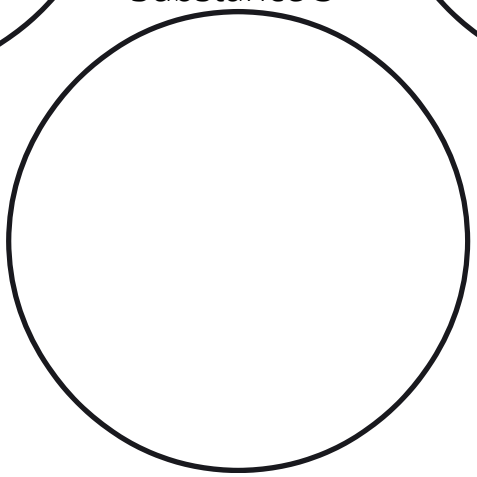
Substance 1



Substance 2



Substance 3



Regional Opportunity Initiatives, © 2021, V1
www.regionalopportunityinc.org/uplands-careers

Name: _____

PLAN

Create a blueprint of the method you will build.
What materials will you use?

Tools used:

Separation Steps:

Step 1:

Step 2:

Step 3:

Step 4:

CREATE

You will have _____minutes.
Use this time to use the method you planned.

Describe the results of your separation method.

Was the method you designed successful?

Name: _____

IMPROVE AND TEST

Revise the method that your group made. Can it be better?

Explain the changes that your group made to your separation method.

Why did your group make these changes?

Was your improved separation method more successful in separating the parts of your mixture? How do you know?

Regional Opportunity Initiatives, © 2021, V1
www.regionalopportunityinc.org/uplands-careers

Name: _____

COMMUNICATE

Share your prototype with the class or another group.

What was the most difficult part of this challenge?

What was the most successful part of this challenge for your group?

What did you learn about Dathan's job as a biomedical manufacturing operator? Why might he be concerned with what is in a mixture and how to separate each component?

Regional Opportunity Initiatives, © 2021, V1
www.regionalopportunityinc.org/uplands-careers

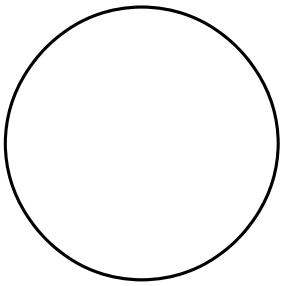
Name: _____

Separate a Solution

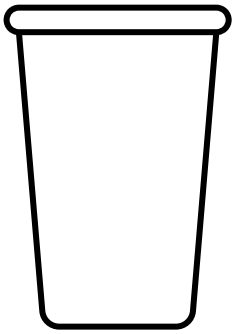
Student Lab Data Sheet

OBSERVE AND RECORD

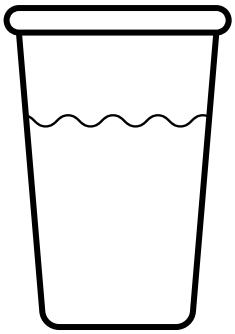
Observe and record the physical properties of each substance.



Salt:



Water:



Salt and Water Solution:

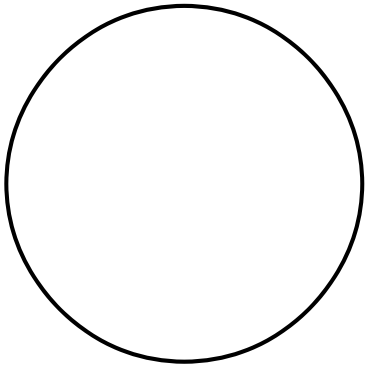
What happened when the salt and water were mixed?

Name: _____

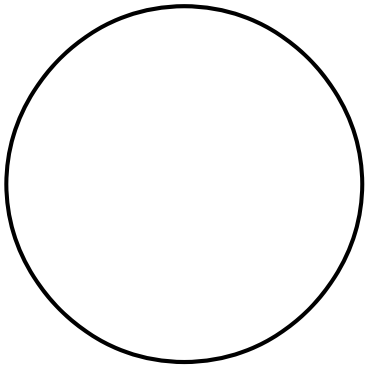
SEPARATION OBSERVATION

Observe what happens to your solution in the shallow dish over a few days.

Observation #1:



Observation #2:



Describe what happened to the salt water into your shallow dish over time. What do you see in the dish after the water has evaporated?

ACKNOWLEDGEMENTS

Activities developed and written for Regional Opportunity Initiatives by

Emily Menkedick
Education Specialist

Adrienne Evans Fernandez
Education Specialist

ROI would like to thank the following members of our Educator Advisory Group for their gracious support and review of this curriculum:

Amy Gordon
Elementary STEM Coordinator
Brown County Schools

Kelly Grimes
7th Grade Science Teacher
Richland-Bean Blossom
Community School Corporation

Alexis Harmon
Academy of Science &
Entrepreneurship Principal
Monroe County
Community School Corporation

Alison Kern
6th Grade Science Teacher
Mitchell Community Schools

Joann Novak
Business & Computer Science Teacher
Monroe County
Community School Corporation

Jean Schick
High School Science Dept Chair (Ret)
Monroe County
Community School Corporation

Katy Sparks
STEM & Computer Science Coach
Monroe County
Community School Corporation

Tara Weisheit
4th Grade Teacher
Washington Community Schools

IMAGE AND CONTENT CREDITS

Images

Stock photography courtesy of Canva.com
Still video images from "Dathan - Drug Substance Operator," http://www.regionalopportunityinc.org/dathan/
"Science Crash Course Kids: The Great Picnic Mix Up," https://www.youtube.com/watch?v=jAOPzbIYPUM

Content

Lesson adapted from Separating Iron Filings, Salt and Sand. (2020, February 21). Retrieved from: https://www.primaryconnections.org.au/sites/all/modules/primaryconnections/includes/SBR/data/Chem/sub/sepironfil/sepironfil.htm.

Operation Separation

Inspired by Dathan, a Biomedical Manufacturing Operator in the Indiana Uplands.

Published by Regional Opportunity Initiatives