STEM Lesson Plan:

Connecting the National MagLab to the Phosphate Industry in Central Florida in the Future

STEM Rationale:

This lesson plan is designed to review information on mixtures, address the importance of one of Florida's critical natural resources, and inform and inspire students on the importance of phosphate and the phosphate industry and how to rethink its damaging gypsum stacks. The health of our ecology and our industry in central Florida depends upon our wise use of this limited resource and conscious management of its byproducts. Identifying the specific valuable rare earth minerals that are trapped within the gypsum stacks might provide students to engineer potential separation methods that are both safe and profitable during the mining process, therefore reducing the need for potential danger from storage of this waste.

The MagLab's research is to find ways to use carbon to identify important rare earth minerals.

Florida Science Benchmark:

- SC.4.E.6.6 Identify resources available in Florida (water, phosphate, oil, limestone, silicon, wind, and solar energy).
- SC.5.P.8.3 Demonstrate and explain that mixtures of solids can be separated based on observable properties of their parts such as particle size, shape, color, and magnetic attraction.
- SC.5.P.8.4 Explore the scientific theory of atoms (also called atomic theory) by recognizing that all matter is composed of parts that are too small to be seen without magnification.

Next Generation Science Standard:

- MS-ESS3-3 Earth and Human Activity. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- HS-ESS3-4 Earth and Human Activity. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

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- 5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment
- 5-PS1-3. Make observations and measurements to identify materials based on their properties. [Clarification Statement: Examples of materials to be identified could include baking soda and other powders, metals, minerals, and liquids. Examples of properties could include color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, and solubility; density is not intended as an identifiable property
- 5-PS1-4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

STEM RATIONALE FOR LESSON:

Students will discuss the importance of proper environmental disposal and placement of waste. Additionally, they will propose alternative methods of harvesting the needed phosphate while gaining access to the rare earth minerals in the byproduct. This needs to focus on safe and affordable extraction methods that would provide feasible incentive to the mining industry.

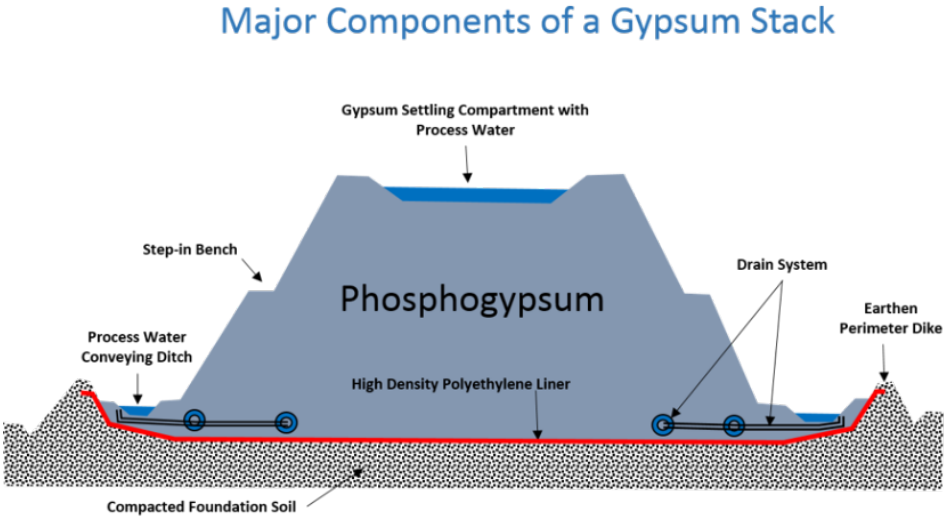
Students might contact local mining companies and survey their approaches to ecology and public policy with consideration towards the economic impact of their waste storage. Analyzing data and making predictions of potential hazards to the environment will provide students with real world opportunities to create solutions. These innovative ideas may provide inspiration for technological advancement.

China has recently implemented restrictions on the export of several rare earth minerals that play a vital role in technology manufacturing. If research conducted at the Mag Lab confirms the presence of these minerals in the byproducts of phosphate mining, it could present an opportunity to explore domestic sources of these critical materials. In light of evolving global supply dynamics, it may be worth considering whether efforts to develop safe and economically viable extraction methods should be prioritized. Additionally, accelerating this research could align with broader national interests in securing access to essential resources.

STEM Lesson Plan:

NATIONAL MAGLAB
Research Experiences FOR TEACHERS

In 2016 a sinkhole opened beneath a Mosaic gypsum stack at its Mulberry plant, draining 215 million gallons of wastewater from a pond on the top of the stack into the aquifer beneath.



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Materials needed (for each group):

- Lab materials, plan sheet for mixture separation, and lab report for mixture separation activity
- Internet access for research
- Notebooks and pens for students

Engage:

1. **Pose a Guiding Question:** Why would materials need separated in the phosphate mining process? What properties would make separation easy? Difficult?

2. **Display** picture of gypsum stack from Bartow, FL; ask students if they have driven by this? What do they think it is? Is it positive or negative for the community? Display picture of Bonnet Springs Park in Lakeland, FL, and ask the same questions.

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Explore:

1. **Have students complete** pre-lab sheet independently.
2. **Divide the Class into Small Groups:** Organize students into small, diverse groups to encourage collaboration. Have students compare their pre-lab sheets and devise a plan based on their shared thoughts
3. **Approve** team plans and have group representative p/u materials and lab report
4. **Class Discussion:** Facilitate a class-wide discussion of separation methods and encourage students to engage with one another's findings. Additionally, encourage discussion on how this relates back to the gypsum stacks and phosphate mining processes. Following is a general form to facilitate discussion – alter to meet your materials used:

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Conclusion:

Explain the science behind the steps you took to separate your mixture.

What **physical properties** of the different substances were important in planning your procedure?

I used _____ to separate the **iron and pins** because they are _____ ...

I used _____ to separate the **lentils and beads** because they are _____...

I used _____ to separate the **sand** because it is _____...

I used _____ to separate the **glitter** because it is _____...

I used _____ to separate the **salt** because it _____...

I used _____ to separate the **pepper** because it _____...

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Explain:

1. **Lead a Discussion on Science's Role in Addressing Environmental Injustice:** Begin by asking students to share their thoughts on how science plays a crucial role in combating environmental injustices. Highlight examples such as:
    a. **Job creation**: Does the positive economic impact outweigh the potential negative impacts on the environment and human health? (Approximately 8,400 jobs are directly connected to the phosphate industry in Floriday – nearly 50,000 indirectly ... the industry's economic impact in the Tampa region is estimated at $4.03 billion.)
    b. **Environmental Monitoring:** Discuss how scientists use tools and techniques to track pollution levels, monitor air and water quality, and gather data on ecosystem health in communities affected by environmental injustice. Should we trust companies like Mosaic to self-monitor?
    c. **Health Studies:** Explore how scientific research can reveal the links between environmental exposure (e.g., toxins, pollutants) and public health outcomes, particularly in marginalized communities.
    d. **Policy Recommendations:** Highlight how scientific evidence is essential in influencing policymakers to enact regulations that protect vulnerable populations from environmental hazards, using scientific findings to advocate for justice.

2. **Introduce the Role of the National MagLab:** Present the cutting-edge scientific research conducted at the National MagLab and explore how its resources can contribute to solving environmental injustice. Discuss potential applications such as:
    a. **Advanced Environmental Monitoring:** Explain how the National MagLab's technologies could be used to monitor environmental pollutants at a more precise level, providing critical data for affected communities.
    b. **Innovative Materials Science:** Highlight the Lab's research in materials science and how it could be applied to developing sustainable technologies or solutions that reduce environmental impacts in underserved areas. Stress the innovative research into how new material separation methods could provide critical rare earth minerals to manufacturing of their favorite items – their cell phones!

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c. **Educational Outreach:** Discuss how the MagLab's commitment to science education and outreach can empower students and communities with knowledge to advocate for environmental justice.

Elaborate:

1. **National MagLab Instrument Integration:** Instruct students to propose a method to either alter the mining process or disassemble the gypsum stacks that incorporate an instrument or technology from the National MagLab. This could include tools for precise environmental monitoring, advanced materials science, or other relevant applications that highlight the Lab's cutting-edge capabilities. Encourage creativity in thinking about how these technologies can be applied to real-world problems.
2. Student tutorial and Model Elicit Activity from CPALMS: Fertilizers in Florida Growing Green, Inc. is planning to expand their business into Florida. The cl ...

Growing Green, Inc. is planning to expand their business into Florida. The client has specific criteria for selecting a good location to set up their new fertilizer manufacturing plant. This project will familiarize students with some of Florida's natural resources (with a great emphasis on phosphate) and will present students with opportunities to interpret different types of maps.

Evaluate:

Students will be evaluated on their active participation in the materials sorting lab and completion of lab reports. Additionally, authentic class discussion will be self-evaluated as well as evaluated by the teacher. Students should demonstrate creativity and scientific learning.

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Resources:

What happens when phosphorous runs out? Hopefully we never find out. – The NAU Review

In the Shadow of Phosphate: A Data Story on Life Near Industry in Florida - The Price of Plenty (wuft.org)

Solid waste - Gypsum stacks (arcgis.com)

What Mosaic Is Doing With Its ‘Gypstack’ To Prevent Another Piney Point Disaster | WUSF

Our Industry – Florida Phosphate Council

Frequently Asked Questions | Native Knowledge 360° - Interactive Teaching Resources (si.edu)

https://www.cpalms.org/PreviewResourceLesson/Preview/70004

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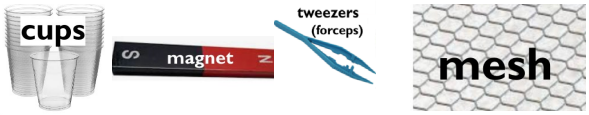
PRE-Lab (Honors) **- Mixture Separation** (25/26) Name _____Pd _____

MAKE YOUR PLAN **Physical GOAL**: Separate all parts of the mixture. **Learning GOAL**: (See board.)

MIXTURE: Sand, Gravel, Iron, Paper, Styrofoam, and Salt

Equipment:



A. **PREPARE**: BRAINSTORM together with your lab team about your lab equipment and separation methods & decide which are best to separate out each mixture ingredient according to its physical properties.

CUPS What is the purpose of the cups? _____

Magnet 

Which mixture ingredient/s would the **magnet** help separate out? _____

What **method** is this? _____ What physical property does it target? _____

MESH 

(coarse - largest holes)

Which mixture ingredient/s would the **coarse mesh** help separate out? _____

What **method** is this? _____ What physical property is targeted? _____

MESH 

(fine - smallest holes)

Which mixture ingredient/s would the **fine mesh** help separate out? _____

What **method** is this? _____ What physical property is targeted? _____

TWEEZERS 

Which mixture ingredient/s would the **tweezers** help separate out? _____

What **method** is this? _____ What physical property is targeted? _____

FUNNEL, FILTER, Filter Paper, & BEAKER

What **method** is this for? _____ What physical property is targeted? _____

Which mixture ingredients would this equipment help separate out? _____

What ingredient must be added to use this method? _____

BEAKER and Hot Plate

What **method** is this for? _____ What physical property is targeted? _____

Which mixture ingredients would this equipment help separate out? _____

What ingredient must be removed to retrieve your original ingredient? _____

B. **WRITE TEAM PROCEDURE PLAN** below. (Honors)

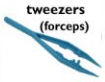
MIXTURE INGREDIENTS:






: Sand, Gravel, Iron, Paper, Styrofoam, and *Salt (ONLY HONORS actually separates out the salt.)

TOOLS:



1. **FIRST**: What will you separate FIRST? _____
   Method to separate this from the mixture _____
   Physical Property targeted _____
   Equipment needed: _____

2. **SECOND**: What will you separate next? _____
   Method to separate this from the mixture _____
   Physical Property targetted _____
   Equipment needed: _____

3. **THIRD**: What will you separate next? _____
   Method to separate this from the mixture _____
   Physical Property targeted _____
   Equipment needed: _____

4. **FOURTH**: What will you separate next? _____
   Method to separate this from the mixture _____
   Physical Property targeted _____
   Equipment needed: _____

5. **FIFTH**: What will you separate next? _____
   Method to separate this from the mixture _____
   Physical Property targeted _____
   Equipment needed: _____

6. **SIXTH**: What will you separate next? _____
   Method to separate this from the mixture _____
   Physical Property targeted _____

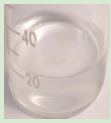
Equipment needed: _____

TEACHER PRE-APPROVAL SIGNATURE: _____ before you start the separation.
Completed separation of all ingredients? **Teacher Signature _____**

CLEANUP PLAN: Keep wet and dry ingredients separated. After teacher signs off it is completed, put dry Ingredients back in the _____. Wet ingredients go _____

Pre-Lab Mixture Separation (Honors)

#	MIXTURE	**Separation METHOD** to best separate these mixtures *Name the **METHOD**, NOT ~~equipment~~*	**Physical Property** targeted
1	**Sand** and **Water** 		

2	**Sand** and **Gravel** 		
3	**Poker Chips** of 2 or more different colors 		
4	**Styrofoam** and **Sand** 		
5	**Black Pepper** and **Iron filings** (both small & black)		
6	**Salt** and **Water**  *(solution which all looks the same)*		

Separation Methods: _____

Physical Properties: _____

Separation of a Mixture Lab Report

Purpose:

What was the goal of this lab? _____

List any COMPOUNDS whose ingredients you separated from each other *(example H_2O, did you separate the hydrogen from the oxygen)*? **Or**, **did you only separate the ingredients of MIXTURES from each other**?

What does this lab teach you about **MIXTURES** versus **COMPOUNDS**?

Materials: List and/or draw (and label) the materials you are using and what method each tool enabled you to complete.

Procedure:

Number and List (in order) the steps you took to separate your mixture.

Cleanup: List the steps you took to complete your lab cleanup.

Results:
What observational data confirms that you successfully completed the lab?

Conclusion:
Explain the <u>science</u> behind the steps you took to separate your mixture.

List the PHYSICAL PROPERTIES of the different substances that were important in planning each step of your procedure?

Example: We used _____ to separate out the iron filings because _____.

Do this for every step and substance which you separated out.