

Hydrothermal Liquefaction: Green Waste=Green Energy

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for the STEM Education Center at WPI's Summer 2022 Research Experience for Teachers program

Subject: Chemistry

Grade Level: 11

United Nations Sustainable Development Goal 7:

The research project precisely associates with the United Nations Sustainable Development Goal (UN SDG) number 7, "ensure access to affordable, reliable, sustainable and modern energy for all". The students will be introduced to this goal, environmental justice, and sustainable energy; which will be tied directly with exothermic or endothermic chemical reactions.

Overview

There was a chemical run off from an industry, the chemicals have now gotten into the nearest river. YOU CAN SOLVE THIS!! In order to do so you must complete an analysis of the chemicals in the mixture first. You can perform this by utilizing chromatography, since it's a separation method that helps you identify the components in a mixture. After such compounds are identified, describe their physical properties.

Standards & Learning Targets

PS1. Matter and Its Interactions

HS-PS1-11(MA) Design strategies to identify and separate the components of a mixture based on relevant chemical and physical properties.

Clarification Statements: Emphasis is on compositional and structural features of components of the mixture. Strategies can include **chromatography**, distillation, centrifuging, and precipitation reactions. Relevant **chemical and physical properties** can include melting point, boiling point, conductivity, and density.

Vocabulary	Tier 1	Tier 2	Tier 3
	<ul style="list-style-type: none"> Identify Separate Mixture Relevant 	<ul style="list-style-type: none"> Design Strategies Components 	<ul style="list-style-type: none"> Physical properties Chemical Chromatography Polar Non-Polar
What do students need to KNOW ?	<ol style="list-style-type: none"> Students will use the following vocabulary words in context: Chemical and physical properties, Chromatography Students will be able to distinguish between polar and nonpolar, and separation techniques. 		
What do	<ol style="list-style-type: none"> Be able to identify and separate components of a mixture based on 		

students need to DO ?	<p>their chemical and physical properties.</p> <ol style="list-style-type: none"> Identify the polarity of compounds Be aware of the effects of polarity in physical properties such as boiling point, and use it to their advantage when separating compounds. Understand how to perform chromatography by TLC (Thin-layer chromatography) to separate compounds.
What will students CREATE ?	<ol style="list-style-type: none"> Students will perform an experiment Complete a write-up/lab report Connection to real world problems

Prior Knowledge

How to determine the polarity based on electronegativity
 Find the difference of electronegativity of the atoms involved

- If it was between 0.4-1.7 it's polar
- Below 0.4 is not-polar

Materials/Resources

Paper, cup, pencil, tape, water, ruler, sharpie (can be performed using recycled materials such as plastic water bottles)

Timeline of Activities

Activity	Instructions	Product
Introduction	Share with the students RET project for them to gain insights on the project and ask them to identify separation methods utilized in it.	Learning of green waste conversation to green energy, and separation methods.
Do now	Image of oil not mixing with water having a discussion with students about the possible reasons why?	Allows students to create a connection with something they have previously seen
Problem + experiment	Present the problem to student and allow them to perform the experiment (teacher can also perform a sample experiment), where students get to simulate the chromatography of TLC plates as well as a gas chromatograph (which I used during my research to identify which compounds were in the aqueous mixture) but with water instead of a chemical and normal paper/napkin.	Gain lab skills, knowledge, and write lab report

Discussion	Class discussion about the lab, is our sharpie ink polar or nonpolar why? Also, show students how to calculate Rf values of our experiment and why it is important.	Reflect
Exit ticket	Did you obtain a good Rf value (should be between 0.2-0.8), what was it? Do you think the size of your paper matters? Why or why not?	Analyze

Culturally Responsive Teaching Strategies

<i>Incorporate culturally relevant teaching</i>	<i>Emphasizes social justice (climate change/environmental justice)</i>
<i>Making it a safe place</i>	<i>Students can feel free to share ideas and trial an error (room to fail)</i>
<i>Adjusting to the students learning needs</i>	<i>Get students from where they are to allow them to grow, instead of assuming they are supposed to know certain material already</i>

Career Connections

- *By explaining research to the students*
- *Project based learning*
- *Allowing them to experience a hands on activity/perform experiment*
- *Enhancing teamwork in the classroom*
- *Giving the space for them to discuss with their classmates and analyze*

Assessment



Assessment (evidence of learning)

- Lab experiment - includes completion of lab report/write-up

Checklist	Scores			Pts
<p>Title, Names, Abstract</p> <ul style="list-style-type: none"> - Descriptive title. - Abstract summarizes background, purpose, results and conclusions. - Abstract written in past tense. 	<p>1 to 0.5 pts very good</p>	<p>0.5 pts good</p>	<p>0.5 to 0 pts poor</p>	<p>1 pts</p>
<p>Methodology</p> <ul style="list-style-type: none"> - Includes sufficient information to follow procedure. - Includes data analysis methods and equations. - Written in full sentences, paragraph format with section headings, past tense, passive voice. 	<p>2 to 1.5 pts very good</p>	<p>1.5 to 0.5 pts good</p>	<p>0.5 to 0 pts poor</p>	<p>2 pts</p>

