Chemical vs. Physical Changes through Water Purification

High School Physical Science
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Idaho State Science Performance Standards:

- **PSC1-HS-1** Develop models to describe the atomic composition of simple molecules and extended structures.
- **PSC1-HS-3** Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.
- **MS-PS1-2** Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

Science & Engineering Practices:

- Analyzing and interpreting data
- Obtaining and evaluating and communicating information
- Planning and carrying out investigations

Idaho Math & ELA Standards:

ELA/Literacy

- **WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS1-2)
- **WHST.9-12.5** Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (HS-PS1-2)
- **RST.11-12.1** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-PS1-3)
- **WHST.9-12.7** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-PS1-3)
- **WHST.11-12.8** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each

source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS1-3)

- **WHST.9-12.9** Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS1-3)

Mathematics

- **ID.HSN-Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS1-2)
- **HSN-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS1-2)

Learning Objectives:

What will students be able to do, know, understand, etc?

1. Students organize given data about the characteristic physical and chemical properties (e.g., density, melting point, boiling point, solubility, flammability, odor) of pure substances before and after they interact.
2. Students organize the given data in a way that facilitates analysis and interpretation.
3. Students analyze the data to identify patterns (i.e., similarities and differences), including the changes in physical and chemical properties of each substance before and after the interaction (e.g., before the interaction, while a substance burns, after the interaction, the resulting substance does not burn).
4. Students use the analyzed data to determine whether a chemical reaction has occurred.
5. Students support their interpretation of the data by describing that the change in properties of substances is related to the rearrangement of atoms in the reactants and products in a chemical reaction (e.g., when a reaction has occurred, atoms from the substances present before the interaction must have been rearranged into new configurations, resulting in the properties of new substances).
6. Students describe the phenomenon under investigation, which includes the following idea: the relationship between the measurable properties (e.g., melting point, boiling point, vapor pressure, surface tension) of a substance and the strength of the electrical forces between the particles of the substance.
7. Students develop an investigation plan and describe the data that will be collected and the evidence to be derived from the data, including bulk properties of a substance (e.g., melting point and boiling point, volatility, surface tension) that would allow inferences to be made about the strength of electrical forces between particles.
8. In the investigation plan, students include:
    a. A rationale for the choice of substances to compare and a description of the composition of those substances at the atomic molecular scale.
    b. A description of how the data will be collected, the number of trials, and the experimental set up and equipment required.
9. Students describe how the data will be collected, the number of trials, the experimental set-up, and the equipment required.

10. Students collect and record data — quantitative and/or qualitative — on the bulk properties of substances.
11. Students evaluate their investigation, including evaluation of:
    a. Assessing the accuracy and precision of the data collected, as well as the limitations of the investigation; and
    b. The ability of the data to provide the evidence required.
12. If necessary, students refine the plan to produce more accurate, precise, and useful data.

Essential Question:

How do we know if something is different?

Guiding Questions:

What questions will constantly focus the students on the Big ideas/Critical Question within the unit in student language?

1. How do we know something has changed?
2. What evidence do we have to support this?
3. How can we collect data to see if something has changed?
4. What observations can we make to see if something is different?

Misconceptions/Evolving Conceptions:

What might students commonly misunderstand about the subject? How will I directly address these?

- Evolving Conception 1: Phase changes are physical changes.
    - Students will be provided with water as an example. They will test water, then use fractional distillation to evaporate the water into steam, then condense it back into a liquid and re-test it.
    - Students will also have the opportunity to discuss the difference between ice, steam and liquid water in a bell ringer discussion and be asked to identify the differences.
- Evolving Conception 2: A property is different than a change.
    - Students will use vocabulary and card sorts to differentiate between properties and changes and be given many examples.
    - This will also be addressed through lab activities as students will use the properties to identify the changes that have occurred.
- Evolving Conception 3: Color is a physical property but most often a chemical change.
    - Color can be both a chemical and physical change. When it occurs with a chemical change there is often more than one indicator that a change has occurred or it is the result of a reaction. Students will practice identifying changes in multiple ways.

Scaffold of Activities:

What is your lesson sequence you will use to get students to the culminating project?

These lessons are taught on a 90-minute block.

1. **Frontloading/Introduction (Day 1)**
    a. How do we know something is different? Slideshow and activities.
2. Chemical vs. Physical Change Reading w/ Marking the Text and Group Posters introduce the key vocabulary for the unit and have students practice identifying chemical and physical changes and properties.
3. Chemical and Physical Changes in Water Systems News Articles/Jigsaw Reading expose to students to current/past issues with water quality and how chemical and physical changes impact these.
4. Physical vs. Chemical Changes Lab gives students practice identifying chemical and physical changes during reactions as well as practice lab safety and performing lab skills.
5. Physical Property Investigation with Density helps students construct scientific arguments based on their observations, practice measuring, evaluate data using precision and accuracy, differentiate between items based on physical properties, and design and conduct an experiment.
6. Sports Drinks - Students will perform a variety of chemical and physical tests on three different liquids to identify chemical and physical properties. After they go through the initial 5 tests, they will separate the liquids based on boiling points and re-test the liquids that they separated to determine if they are different or the same.
7. Water Treatment Plant In this assignment, students watch a video about water treatment plants and then do a reading. The follow up questions focus on key processes and vocabulary to help students understand the connection between our lab activities and real world connections.

Ongoing Formative Assessments:

- Chemical vs. Physical Change Google Form - The purpose of this assignment is to use lab data to answer questions and then connect that information.
- Notecards - These notecards show initial student ideas and then how those ideas changed after doing a lab focusing on density.
- Density calculations and conceptual questions - The purpose of this assignment is to use lab data to answer questions and then connect that information. This Google forms shows questions that were asked and Student responses.
- CER - Is it water? These CER examples show how students summarized their lab findings and showed their knowledge on a scaffolded lab testing different drinks to see what they contained.
- Research Checkpoints - Along the way students were ask to continually narrow down their projects and research ideas through Google form check points topic selection and initial research) and submitting rough drafts of their projects through Google classroom or as a hard copy.

Summative Assessment/Culminating Project:

Students will apply what they are learning about chemical and physical changes to a water quality issue and then propose a solution that fits the target audience that is impacted by the water quality issue. This lesson includes all of the scaffolds and learning opportunities to help students select a topic that they are interested in, as well as all of the research days and culminating project rubric. When implemented these days are spread throughout the unit and not consecutive.

Additional Helpful Resources:

Sources for lessons, website, etc.

- NSTA, CER Collection. Accessed from:
- CER Collection
- Boise Water Shed Boise WaterShed
- JPL, NASA Water Filtration Challenge Activity | NASA/JPL Edu
- Water Webaquest https://www.oneida-boces.org/cms/lib/NY01914080/Centricity/Domain/178/water_webquest.doc