**Unit Essential Question:** *How does energy and matter flow within natural and designed ecosystems?*

**Introduction**

In the Lift-Off Task, students were introduced to environmental changes within the context of a river environment. As they noticed changes that occurred over hundreds of years, they were implicitly beginning to think about the chemical and physical processes involved in environmental change. In this task, students dig into the science behind some of these changes by learning about both physical and chemical changes. They learn that not all changes are the same; in some, the substances remain constant while in others, the substances change entirely. Through data analysis, they will find that looking at the properties of substances before and after the change is key to determining what type of change it is. By the end of this task, students will be able to use their scientific understanding of physical and chemical changes to help them explain real phenomena in river environments, thus paving the way to apply this knowledge in a designed setting, like their aquaponics system.

**Alignment Table**

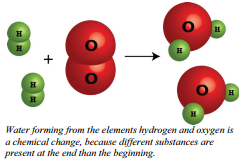
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| **Performance Expectations** | **Science and Engineering Practices** | **Disciplinary Core Ideas** | **Crosscutting Concepts** |
| **MS-PS1-2. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.** [Clarification Statement: Examples of reactions could include burning sugar or steel wool, fat reacting with sodium hydroxide, and mixing zinc with hydrogen chloride.] [Assessment Boundary: Assessment is limited to analysis of the following properties: density, melting point, boiling point, solubility, flammability, and odor.] | **Analyzing and Interpreting Data**   * Analyze and interpret data to determine similarities and differences in findings. | **PS1.A: Structure and Properties of Matter**   * Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.   **PS1.B: Chemical Reactions**   * Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules and these new substances have different properties from those of the reactants. | **Patterns**   * Macroscopic patterns are related to the nature of microscopic and atomic-level structure. |
| **Equity and Groupwork**   * Work within group roles to successfully analyze data. | | | |
| **Language**   * Use models to construct own definitions of physical and chemical changes. * Write conclusions based on data analysis. | | | |

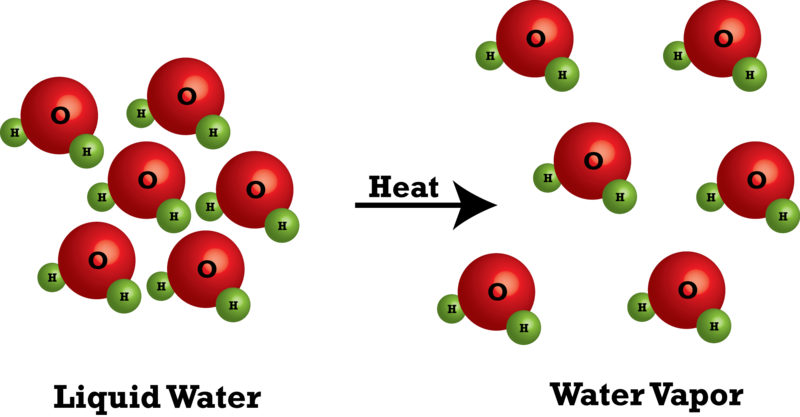
**Learning Goals**

This learning task asks students to observe the differences between a physical and chemical change. More specifically, the purpose is to:

* Use prior knowledge to group types of environmental changes in the river environment.
* Explore data on the properties of substances before and after an environmental change.
* Use models to help identify the above environmental changes as physical or chemical.
* Apply understandings to a process involved in decomposition.
* Apply knowledge of physical and chemical changes to an aquaponics system design.

**Content Background for Teachers**

 In this task, students start to make sense of some of the science behind the changes they see in an environment. In this task, students attempt to separate the changes they see into two categories—physical and chemical changes. The difference between a physical change and a chemical change is composition. In a chemical change, the matter changes into a completely different type of matter, meaning that the original molecules are rearranged into different molecules (see image to the right). In a physical change, the matter stays the same but there is a change in size, shape, state, or appearance (see image below).

 Some examples of physical changes are physical manipulations such as ripping paper or changes of state, such as freezing water or melting candle wax. These do not change the internal composition of the item. In chemical changes, however, the composition is changed, and so do the properties of the substances. While students cannot see atoms with the naked eye, there are a number of clues to tell them that a chemical reaction has occurred. To identify a chemical change, they need to look for observable signs, such as color change, bubbling and fizzing, and the presence of light, smoke, heat, and/or odor. This method of identifying chemical reactions should have been explored in earlier grades. Should your students not be familiar with classifying chemical reactions in this way, review some of the ways in which chemical reactions can be identified.

However, students can also identify whether a change is physical or chemical by looking at the properties of the reactants and the products before the change. Even without the chemical composition of the reactants and products, scientists can look at the properties of each. If properties, such as density, boiling point, melting point, and solubility are different between the reactants and the products, that suggests that new molecules were formed, and thus a chemical reaction occurred. This way of identifying chemical reactions will be explored in this task.

Investigating physical and chemical changes are just the starting point for future explorations of chemical reactions to come throughout the unit. Soon, students will begin to explore specific chemical reactions relevant to their study of environmental changes, zooming in to the molecular level and considering conservation of matter in an environmental system. As students work through this introductory task distinguishing physical and chemical changes, it is helpful to keep these connections in mind.

**Academic Vocabulary**

* Physical Change
* Chemical Change
* Properties
* Reactants
* Products
* Glucose
* Decomposition
* Molecules
* Amino Acid
* Nitrogen

**Time Needed (Based on 45-Minute Periods)**

3 Days

* Engage: 0.5 period
* Explore: 0.5 period
* Explain: 0.5 period
* Elaborate: 0.5 period
* Evaluate and Reflection: 1 period

**Materials**

* Unit 3, Task 1 Student Version

Evaluate

* Project Organizer Handout

**Instructions**

**Engage**

1. Introduce Task 1: In the Lift-Off Task, you saw images of a river environment 200 years ago and the river environment today. Think about what you were still wondering about at the end of the last task (look back if you need to). What questions do you still have?
   * Before you pass out their student guide, give students time to reflect individually or with a partner about the questions they recorded at the end of the last task. Share a few of these out as a class, using facilitating questions to guide students toward questions that relate to this task.
2. Transition to Task 1: You likely observed many differences between the past and present river environment. What processes are behind these differences? In this task, you will investigate the kinds of changes that happen in environments over time.

* Now pass out the Task 1 student guide.

1. With a partner, have students return to the past and present images of the river environment and make a list of all the differences they observe between the two.

* Once students generate a list, have pairs of students group the differences into similar types of changes and record those groupings.
* Recommended: Project the images class-wide and co-construct groupings of similar types of environmental changes. Use equity sticks for more equitable participation (See “How to Use This Curriculum” for details).

**Explore**

1. In the Engage, students began to think about the different kinds of changes that happen in environments over time. In this activity, students learn more about these environmental changes by analyzing and interpreting data from two common changes—plant growth and fog rising off water.
2. Assign roles to each group. You may use whatever roles you prefer. We recommend the use of the Materials Manager, Facilitator, Harmonizer, and Recorder.
   * Ask the Facilitator to read the directions and to make sure everyone understands the task.
   * Ask the Materials Manager to handle any resources needed to complete the task, including reading the data sets aloud.
   * Ask the Harmonizer to make sure that everyone contributes their ideas and that everyone’s voice is heard.
   * Ask the Recorder to make sure the group is recording their observations in their student guides.
3. Students will examine the properties of the substances before and after each of the environmental changes has occurred. Because students may not know the definitions of some of the properties (ie. density), make it clear to students that they just need to focus on the difference in numbers to understand the difference in properties.
   * This requires students to use the SEP of **Analyzing and Interpreting Data** as they look for similarities and differences between the two data sets.
   * Students will also engage with the CCC of **Patterns** as they begin to notice macroscopic **patterns** in the data (properties of substances), which they will be able to compare to microscopic patterns in atomic-level structures in the next section of this task.
4. The first data set is an example of a chemical change while the second data set is an example of a physical change. Students are not yet introduced to these terms; instead they are asked to investigate the data with guided questions that are intended to help them notice differences or similarities between the properties of substances in both data sets. The last question asks them to compare the two data sets, which will help transition them to the next portion of the task.
   1. Plant Growth: Students should notice that the properties of the reactants are different from the products.
   2. Fog Rising Off Water: Students should notice that the properties of the reactants are the same as the products.
   3. Comparison of Two Data Sets: Students may notice that there is more variation in reactants and products in Data Set 1, but only water in Data Set 2. Students may also notice that the substances don’t change in Data Set 2, but they do in Data Set 1.

**Explain**

1. Now that students have explored the data, it is time to introduce them to the relevant scientific terminology: physical change and chemical change.
2. Rather than giving students the explicit definitions, models are provided for each type of change that students interpret and use to craft their own definitions in pairs.

* We recommend pausing partner work after this first question and coming to a class consensus on definitions for physical and chemical changes. Keep in mind that it takes time to reach consensus and it is okay if complete consensus is not reached.
* Students will likely notice that in a physical change, the molecules remain the same while in a chemical change, the molecules change into new molecules.

1. Once students have an understanding of physical vs. chemical changes, they can apply this information to the data sets from the *Explore*. In pairs, students look back at the data, identify each data set as a physical or chemical change, and explain why.
   * This explicitly emphasizes the CCC of **Patterns** as students relate the macroscopic patterns of properties to what is happening at the microscopic level with atomic structure. They are also continuing to **Analyze and Interpret Data** as they did during the *Explore*.
2. Lastly students return to their lists from the *Engage* and make predictions about which changes they think are physical and which are chemical based on what they have learned during this task. These predictions need not be accurate at this point since they don’t have all the essential information. However, students should be using their new knowledge of physical and chemical changes as part of their reasoning.

**Elaborate**

1. This activity asks students to use the knowledge they have gained throughout the task and apply it to another environmental change present in the river environment—the decomposition of the deer.
   * Here students are introduced to a concept they should have learned before—decomposition. For students who are not familiar with this term, we recommend spending some time reviewing it as a class using the information in their student guide.
   * This scenario specifically focuses on a chemical process that converts one form of nitrogen into another more useable form for plants.
2. Similar to the Explore, students are given a data table showing the properties of substances before and after a reaction.
   * Again, students are practicing the SEP of **Analyzing and Interpreting Data** and the CCC of **Patterns**, as they analyze similarities and differences in macroscopic patterns to infer changes in microscopic structures.
3. Student responses to this question represent an opportunity for formative assessment. Collect student work to identify trends in students’ ability to relate macroscopic patterns to atomic-level structure as they identify this process as a chemical or physical change. See “How to Use This Curriculum” for strategies on utilizing formative assessment data to provide feedback to students and inform classroom instruction.
4. Return to the whole-class concept map from the Lift-Off Task.

* In small groups, have students brainstorm new concepts and new connections that they have learned in this task, as well as any new questions that have come up for them. Then have groups share these aloud in a class-wide discussion and add to the class concept map. The use of equity sticks is encouraged for more equitable participation in class-wide discussions (See “How To Use This Curriculum” for more details).
  + Some possible facilitating prompts to ask students are: What new ideas/concepts do you want to add to the map? What connections do you want to add or change? What is your reason for that addition/revision? What connections can we make between the questions/ideas already on the map? What new questions do you have about the phenomenon?
  + Draw circles around each question and boxes around each concept.
  + Write connector words to describe connections between the concept boxes.
  + For this task, students may begin to connect some of their previous question circles to concept boxes about the following: types of environmental changes (physical vs. chemical).
* Have students analyze the additions to the class concept map for as many examples of this task’s crosscutting concept as they can find. Once a student has identified the crosscutting concept, you can trace the circle in the corresponding color (decided on in the Lift-Off task). We recommend asking students to share key words that helped them identify the crosscutting concept for that concept or question. Some identifying words students might look for are:
  + **Patterns**: These could be phrases such as, “has in common with” “shares,” “is also shown in,” “is the same as,” “looks the same as,” etc.
* Once again, the purpose of this concept map is to facilitate the generation of student questions, promote language development, and support understanding of the science content throughout the unit. Allowing students to ask their own questions and use their own words to make meaning of the concepts will not only help them make deep connections about science content, but will also help their oral and written language development.

**Evaluate: Connecting to the Culminating Project**

1. Students independently complete the Task 1 section of the Unit 3 Project Organizer in class. Revisions can be done for homework, depending upon student’s needs and/or class scheduling.
2. Students have been tasked with creating a sustainable aquaponics system that mimics the properties of the river environment, including any physical and chemical changes that may occur. Their prompt is as follows: Now that you understand physical and chemical changes on a molecular level, identify one physical change and one chemical change that you anticipate may occur in your aquaponics system.

* Draw a before and after picture for each change and write a caption explaining each.
  + Use data from this task, or research the properties of your own environmental change, to explain how you know what type of change it is.
* For each factor, decide if it represents a threat to your aquaponics system. If it is a threat, describe a potential solution to prevent it.

1. Since aquaponics systems are likely still new for students, we recommend projecting or providing example images as they complete this section of their project organizer.

**Reflection**

1. At the end of the task, ask students to reflect on what they have learned over the course of this task by answering the following three questions in their student guide:

* At the beginning of this task, you were asked to group the types of changes you observed in the river environment. Look back at your groupings: are they similar to groupings of physical vs. chemical changes? Explain how they are similar or different.
* In this task, we focused on the crosscutting concept of **Patterns**: Macroscopic patterns are related to microscopic structure. Where did you see examples of **Patterns** in this task?
* Now that you have learned more about two types of changes in environments, what questions do you still have?

1. There are no right answers, but encourage students to look back at their student guides and their class concept map. They should not change their initial responses, but rather use this reflection space to add to their ideas and questions based on what they have learned through this task. By generating more of their own questions, students continue to engage in sense-making of the phenomenon and gathering knowledge and skills for their final projects.

**Assessment**

1. You may collect students’ Project Organizer and assess using:

* *Criteria of your choice.* We recommend using the 3-Dimensional Assessment matrix at the beginning of this document to inform your criteria.
* This can be a formative tool to periodically look for trends in student understanding after the completion of a task. You can then use this formative data to inform any re-teaching as necessary.

1. You may also give students time to make revisions with one of the two options:

* Students may make changes to their Project Organizer according to your comments OR
* Ask students to exchange Project Organizers with a partner and give partners 5 minutes to give written feedback. Then allow students time to make changes to their work according to the feedback.