**Unit Essential Question:** *How do people use technology to survive in regions with different climates?*

**Introduction**

In the last two tasks, students explored what causes the different climates they can observe around the world. In this task, they delve into one important aspect of these climates—the water cycle. While students have been exposed to pieces of the water cycle in previous tasks, this task asks them to focus on the specific reservoirs for water, and the mechanisms that move water, allowing them to form a cohesive picture of the water cycle. In this task, students do a kinesthetic activity to take the journey of a water molecule, allowing them to explore the places where water can be found and how it travels. As students compare their journeys with other students, they will realize that water does not take a linear journey, but instead water continuously cycles throughout Earth’s systems. They then use these ideas to construct a poster model that shows the water cycle and dispel a common misconception associated with the evaporation of water. In the end, they will be able to apply their learning to consider how the water cycle creates some of the climate conditions in their chosen region for their culminating project.

**Alignment Table**

|  |  |  |  |
| --- | --- | --- | --- |
| **Performance Expectations** | **Science and Engineering Practices** | **Disciplinary Core Ideas** | **Crosscutting Concepts** |
| **MS-ESS2-4. Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.** [Clarification Statement: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.] [Assessment Boundary: A quantitative understanding of the latent heats of vaporization and fusion is not assessed.] | **Developing and Using Models**   * Develop a model to describe unobservable mechanisms. | **ESS2.C: The Roles of Water in Earth’s Surface Processes**   * Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. * Global movements of water and its changes in form are propelled by sunlight and gravity. | **Energy and Matter**   * Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. |
| **Equity and Groupwork**   * Discuss and compare journeys with group members to combine information into one cohesive model. * Participate in group roles to develop a model of the water cycle. * Give and receive feedback. * Discuss ideas within the *Critique, Correct, and Clarify* technique. | | | |
| **Language**   * Use sequence language within written observations and a visual model. * Compare and contrast journeys with group members. * Use the *Critique, Correct, and Clarify* method to improve language and content. | | | |

**Learning Goals**

This learning task asks students to develop and use models to describe the cycling of water through Earth’s systems. More specifically, the purpose is to:

* Engage prior knowledge of where water can be found on Earth.
* Explore the water cycle through a kinesthetic simulation.
* Explain the water cycle through a visual model.
* Use the *Critique, Correct, and Clarify* method to dispel a common misconception about the water cycle.
* Apply knowledge of the water cycle to explain climate conditions in a chosen region.

**Content Background for Teachers**

 In this task, students explore the water cycle—the movement of water through Earth’s systems, driven by energy from the Sun and the force of gravity. While commonly taught as a linear sequence, keep in mind that the water cycle really has no starting point because it is a cycle.

Most water on Earth is found in saltwater in Earth’s oceans. The sun, which is the energy source that drives the water cycle, heats ocean water. This causes a process called evaporation, in which liquid water changes state into water vapor. This water vapor goes up into the atmosphere. Another way water gets into the atmosphere is through a process called transpiration, in which water evaporates from pores in the leaves of plants undergoing photosynthesis.

When water vapor rises into the atmosphere, it cools, causing it to condense into clouds. When these clouds get heavy enough, gravity (another important force in the water cycle) pulls water down to the ground as rain, sleet, snow, or hail. This is known as precipitation, or in the case of snow, crystallization. Snow can accumulate as ice caps and glaciers, which can then melt and flow overland into various surface water reservoirs (i.e. rivers, lakes, streams, etc.). Rain can fall directly into these surface water reservoirs or the ocean, or it can fall onto land first, where due to gravity, it flows over the ground. This process is called surface runoff, and this water will eventually flow into surface water reservoirs or oceans. Alternatively, rain can seep into the soil and eventually become part of groundwater. Plants and animals also use water from all these reservoirs in order to survive and grow. When animals die, exhale, or excrete, this returns water to the cycle.

 For more information on all of the components and interactions of the water cycle, please reference the *Explore* Station Cards provided.

**Academic Vocabulary**

* Atmosphere
* Surface Water
* Ground Water
* Glacier
* Ice Cap
* Evaporation
* Transpiration
* Condensation
* Precipitation
* Crystallization
* Surface Runoff
* Gravity
* Sun Energy

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

4 Days

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

**Materials**

* Unit 2, Task 3 Student Version

Explore

* Water Molecule Journey Station Cards (2-3 per station) – Hang as posters around the room
* Tape
* Dice (1 per student)

Explain

* Poster Paper
* Markers
* Optional: Post-Its (3 per student)

Evaluate

* Project Organizer Handout

**Instructions**

**Engage**

1. Introduce Task 3: In Tasks 1 and 2, you explored the causes of different climates around the world. 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 3: In this task, we will dig into one specific aspect of climate—water.
   * Now pass out their Task 3 student guide.
3. This brainstorm activity asks students to call upon any prior knowledge they have about water on Earth. In pairs, students discuss the questions: What are some ways that water is a part of different climates? Where do we see water in different environments? They then make a list together in their Student Guides.

* Encourage students to think back to how they defined climate at the beginning of Task 1 and picture different regions around the world. This should help spark ideas during their brainstorm.

1. Share out ideas to create a class list on the board.

* Students will come up with a range of different ideas, such as: rain, snow, hail, oceans, rivers, lakes, streams, ponds, etc. Some of the more difficult examples—like atmosphere, groundwater, plants, animals, etc.—may not come up during this brainstorm, but students will explore these ideas in the next section of the task.
* We encourage using equity sticks to foster more equitable participation in class-wide discussions like these (See “How To Use This Curriculum” for more details).

**Explore**

1. In the rest of the task, students will focus on how water moves through Earth’s systems and the role this plays in the climates people experience. To do this, they will take the journey of a water molecule by engaging in a kinesthetic modeling activity

* This activity gives students practice at the SEP of **Developing and Using Models** as they use a kinesthetic model to explore the water cycle. Specific stations will also emphasize the CCC of **Energy and Matter** as students learn that the transfer of energy (i.e. energy from the sun) drives the cycling of water through Earth’s systems.

1. Set up the stations around the room by posting 2-3 of each station card for students to visit. Explain the directions on their Student Guide. Then provide each student with a dice and assign each of them a station to start their journey.

* Students will move from station to station by rolling the dice and reading the station card to find out where to go next. They should be recording information about each station and how/why they moved in the chart in their Student Guide. Continue this process until they have recorded 10 locations.

1. Possible Completed Chart

* As you can see, students may or may not visit all stations and sometimes they will revisit a station. That is completely okay and helps them to see that this truly is a cycle, not a linear sequence.

|  |  |  |
| --- | --- | --- |
|  | **Location and Description** | **Describe How You Travel To Your Next Location** |
| **1** | **Plants** – Plants need water to grow. | The plant I was in died and decomposed, so I entered the soil. |
| **2** | **Soil** – Soils hold the water that all plants need to grow. | I was just the sort of molecule that plants needed to absorb through their roots, so now I go back into a plant. |
| **3** | **Plants** – Plants need water to grow. | An animal has eaten the plant I was in, so I go into an animal. |
| **4** | **Animals** – Animals need water to survive and do their daily activities. | The animal I was in released me as waste, so now I am in the soil. |
| **5** | **Soil** – Soils hold the water that all plants need to grow. | I gathered on the surface of the soil and so now I am part of surface water. |
| **6** | **Surface Water** – Surface water is any water found above the Earth’s surface, such as lakes, rivers, streams, and creeks. | The sun heated my fellow water molecules and I from a liquid into a gas, so I am now a part of the atmosphere. This process was called evaporation and was driven by energy from the sun. |
| **7** | **Atmosphere** – The atmosphere is the air surrounding the Earth, which contains plenty of water in the form of water vapor (a gas). | As temperature decreased, I joined with other water molecules in the air to form a cloud. This is called condensation. |
| **8** | **Clouds** – Clouds are a visible mass of condensed water molecules. | The temperature decreased, and we became heavy enough, gravity pulled us down to the ground in the form of snow. This process is called crystallization. |
| **9** | **Ice Caps and Glaciers** – Glaciers and ice caps store freshwater in frozen form. | Energy from the Sun heated my friends and I from solid form into liquid form. Propelled by the force of gravity, we flow over the ground and into the ocean in a process called surface runoff. |
| **10** | **Ocean** – Oceans store most of the water on Earth. | The sun heated my fellow water molecules and I from a liquid into a gas, so I am now a part of the atmosphere. This process was called evaporation and was driven by energy from the sun. |

**Explain**

1. In this activity, students in each group compare their different journeys, identifying similarities and places where their paths diverged. The goal of this activity is for students to combine all their journeys to make a poster map that represents a comprehensive picture of the water cycle.

* This activity gives students more practice at the SEP of **Developing and Using Models** as they co-construct a complete visual model to describe the water cycle they just explored. The last bullet point in the list of criteria asks students to emphasize the CCC of **Energy and Matter** as they identify the energy from the sun and the force of gravity that drive the cycling of water through Earth’s systems.

1. Make materials available to students and assign roles to each group. You may use whatever roles you prefer. We recommend the use of the Facilitator, Materials Manager, Harmonizer, and Reporter.
   * Ask the Facilitator to read the directions and to make sure everyone understands the task.
   * Ask the Materials Manager to gather the materials needed to complete the task.
   * Ask the Harmonizer to make sure that everyone contributes their ideas and that everyone’s voice is heard.
   * Ask the Reporter to make sure the group is reporting all relevant components and interactions on their poster.
2. Review the instructions with students. Make sure that students understand that their model should include pictures, words, and arrows, and should meet the list of criteria in their Student Guides. Take any questions before students begin.

* While each student may not have visited all the stations, it is likely that amongst all the group members, all of the stations were visited.
* Encourage students to return to the stations, as necessary, to gather more information that they feel was missing from each of their group members’ journeys.

1. If you feel your students need more support, one optional scaffold is to provide a word bank of terms students must use in their model. Use the list of Academic Vocabulary at the beginning of this Teacher Guide to help you decide on a bank of terms.
2. We highly recommend doing a gallery walk at the end of this activity, so students can showcase their work and gather feedback.

* Provide each student with a few post-its that they can use to leave specific feedback on different groups’ posters as they do the gallery walk.
* Some questions you might post on the board to prompt student feedback are: Are there any connections (arrows) missing? Are there any locations missing where water can be found? Are any of the major processes that move water missing? Are examples of energy and forces that drive the water cycle missing? Could there be more detail added?
* Encourage students to also leave positive feedback when appropriate. You might model this by pointing out a poster that clearly describes how sunlight or gravity is involved in the water cycle.

1. Once students receive feedback, give them an opportunity to revise their models as a group. These final posters are a great option for a quick formative assessment.

* Collect the posters to assess groups’ understanding of the water cycle. See “How to Use This Curriculum” for strategies on utilizing formative assessment data to provide feedback to students and inform classroom instruction.
* You may also want to do a quick debrief as a class to review common strengths and any common issues across the posters before moving on to the next activity.

**Elaborate**

1. Now that students have a solid understanding of the water cycle, they are ready to tackle a common misconception—that water just disappears when it evaporates. Introduce the activity by reading the text from their Student Guide aloud: Imagine that your younger sibling is explaining to you what happens to puddles that dry on the sidewalk. Now that you have investigated the water cycle, critique their explanation using the *Critique, Correct, and Clarify* technique below.

* This activity gives students another opportunity to emphasize the CCC of **Energy and Matter** as they correct the sample to include the accurate source of energy that cycles water—the Sun.

1. Students will be using the language strategy known as *Critique, Correct, and Clarify* to critique the following explanation: *When a puddle dries on the sidewalk, the water disappears completely. This is because the air after a storm creates an energy that makes the water disappear. Water will only be created again by the sky during the next storm.*
   * Students should follow the protocol in their student guide to critique the explanation in partners, individually write an improved explanation, and then discuss with a partner why they corrected the explanation.
   * Optional Sentence Stems to Provide:
     1. When a puddle dries on the sidewalk…
     2. This happens because…
     3. Thus, the water is not disappearing, but is…
     4. The puddle can be created again if…
   * A possible student sample is provided below:
     1. Correct: *When a puddle dries on the sidewalk, the water evaporates from liquid form into water vapor that goes up into the atmosphere. This happens because energy from the Sun heats up the water molecules until they transform from liquid to gas. Thus, the water is not disappearing, but is just taking a different form and continuing through the water cycle. This puddle can be created again if the water vapor in the atmosphere condenses into clouds and then comes back down to Earth as rain.*
     2. Clarify: *The original explanation inaccurately said that water disappeared. Water can’t just disappear; it changes forms during the water cycle and is sometimes invisible to us as a gas in the air. It also said the storm creates an energy, but it is actually the Sun that is the energy that drives the whole water cycle. Also, water is not created by the sky. It is already in the atmosphere; it just needs to condense into clouds and then rain.*
2. The “Correct” and “Clarify” sections are good options for formative assessment. Collect student work to assess students’ understanding of how water cycles between Earth’s systems during evaporation. See “How to Use This Curriculum” for strategies on utilizing formative assessment data to provide feedback to students and inform classroom instruction.
   * We also recommend sharing out a few corrected explanations and justifications after partners have discussed so students can share understanding and you can get an idea of where students are with these concepts.

* Again, we encourage using equity sticks to foster more equitable participation in class-wide discussions like these (See “How To Use This Curriculum” for more details).

1. 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 facilitating questions 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: how water cycles amongst Earth’s systems.
   * 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:
     + **Energy and Matter**: These could be phrases such as, “energy is transferred/flows,” “is conserved,” “is important for,” “is needed,” etc.

* Once again, the purpose of this concept map is to facilitate 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 3 section of the Unit 2 Project Organizer in class. Revisions can be done for homework, depending upon student’s needs and/or class scheduling.
2. Students have been asked to design a product that makes it more comfortable for people to live in a region with an extreme climate. Their prompt is as follows: Think about the region you selected.

* What are some ways that water is a part of your region’s climate?
* Using words or a model, describe the processes that create the water conditions in your region.

**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 brainstorm ways that water can be a part of different climates and places that you can find water in environments. Look back at your initial list: after everything you have learned in this task, what could you add to this list? Record below.
* In this task, we focused on the crosscutting concept of **Energy and Matter**: The transfer of energy drives the motion or cycling of matter, and it can be tracked as it flows through a system. Where did you see examples of **Energy and Matter** in this task?
* Now that you have learned more about a major part of different climates—water—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.