LOCAL HYDROLOGIC CYCLE

UNITE US
INSTRUCTIONS
Grade 7-8

Overview:

The hydrologic (water) cycle is visible in many aspects of our environment. In this lesson, students will review the hydrologic cycle and will identify its stages in their communities and will speculate on possible uses for hydrokinetic energy in their communities.

Objectives:

The student will:

- identify the stages of the hydrologic cycle as they occur in the local area; and
- identify potential for hydrokinetic power use in their communities.

Targeted Alaska Grade Level Expectations:

Science

[7-8] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring, and communicating.

[8] SD1.2 The student demonstrates an understanding of geochemical cycles by applying knowledge of the water cycle to explain changes in the Earth's surface.

Vocabulary:

condensation - the change of a gas or a vapor to a liquid, either by cooling or by being subjected to increased pressure

evaporation - the change of a liquid into a vapor at a temperature below the boiling point

Infiltration - flow of water from the land surface into the subsurface

precipitation - a form of water, such as rain, snow or sleet that condenses from the atmosphere and falls to Earth's surface

runoff - overland flow of water to an ocean

sublimation - the process of changing from a solid to a gas or from a gas to a solid without passing through an intermediate liquid phase

transpiration - the process of giving off vapor containing water and waste products

Whole Picture:

The hydrologic (water) cycle in a localized area is affected by many things including an area's latitude, geography, seasons, and human activity. In this lesson, students will apply what they have learned about the phases of the hydrologic cycle. After review of the hydrologic cycle, students will draw pictures of their local communities. Students may draw pictures of the community in winter or in summer. Drawings must show plants, clouds, and at least one source of water (lake, river, snow, etc.). Other items (buildings, roads) may be added if time permits. Using their drawings, students will illustrate the hydrologic cycle as it occurs in their local areas. Students will explain their illustrations in short presentations to peers. Students will speculate on potential uses of hydrokinetic power in their communities.

Materials:

- Ice cube trays (or small freezer-safe containers) (2)
- Clear container
- Water
- Dirt (or other loosely packed substance such as sifted flour)
- VISUAL AID: "Water Cycle"
- White paper
- Crayons and/or colored pencils and/or colored pens
- STUDENT WORKSHEET "The Hydrologic Cycle in _____."
- STUDENT WORKSHEET "Hydrokinetic Potential in _____."

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Activity Preparation:

1. One week prior to this activity fill one ice cube tray with water and place them in the freezer.
2. One day prior to this activity, place another ice cube tray in the freezer. Make sure that the same amount of water is added to the trays each time.

Activity Procedure:

1. Remind students that the water cycle, otherwise known as the hydrologic cycle, is the circulation of water throughout Earth. Show VISUAL AID: "Hydrologic Cycle." Ask students to explain what happens in each of the phases of the hydrologic cycle. As needed, remind students that transpiration is the process of giving off vapor; evaporation is when water becomes vapor; condensation is when water vapor cools in the atmosphere and tiny drops of water come together to form clouds; and precipitation is when water falls back to Earth in the form of rain, snow, sleet, hail, etc.
2. The other stages of the water cycle are sublimation and infiltration. As a class, ask students to speculate and discuss the meaning of the words "sublimation" and "infiltration" as they apply to the hydrologic cycle. Ask students to explain the difference between speculation and observation. Discuss other questions on which one might "speculate" and then confirm or negate speculations based on "observation."
3. Explain that sublimation is when solid water (ice or snow) changes directly to vapor. Ask students to speculate which ice cube tray would have more ice in it: one in the freezer one week ago or one put in the freezer yesterday. Ask students to justify their speculations.
4. Remove the frozen ice cube trays from the freezer and display to students. Explain that the same amount of water was placed in both trays. One tray was put in the freezer yesterday, the other one week ago. Students should see that the tray placed in the freezer one week ago has less ice in it. Explain this demonstrates sublimation. The ice changed into vapor without first changing into liquid, as it would do if heat were applied.
5. Explain that seeing ice was an observation; one could see how one tray of ice cubes had less ice than the other tray. The class discussion regarding the ice cube tray was speculation, as there was no observable evidence.
6. Explain that infiltration is the downward movement of water through soil. In the hydrologic cycle, infiltration is when water from rain, rivers, lakes, etc. seeps into the ground. Some of this water pools and becomes groundwater, which is where people get water from when they dig a well. Eventually, some of this water seeps back to the surface in the form of a spring. This can be seen at small and large springs, such as Chena Hot Springs in Fairbanks, Alaska.
7. Explain that infiltration is possible because soil is not a solid mass; there are pockets of air through which water can move. Demonstrate by slowly pouring water over the clear container filled with soil. Students should be able to see the water pool into the bottom of the container.
8. Pair students to work on the activity "The Hydrologic Cycle in (name of community)_____."

   Hand out the STUDENT WORKSHEET: "The Hydrologic Cycle in_____" with instructions for drawing and presenting. Hand out the paper and drawing materials. Ask students, "Are there phases of the hydrologic cycle that are observable and those that are speculation? Which phases fit into each category?"
9. The second section of the lesson based on the STUDENT WORKSHEET "Hydrokinetic Energy Potential in _____", may be taught as a separate lesson subsequent to : "The Hydrologic Cycle in_____."
10. Hand out STUDENT WORKSHEET: "Hydrokinetic Energy Potential in _____." Ask students to complete the worksheet.
11. After the worksheet is completed discuss student responses, Ask students to share local knowledge about rain or water in the manner of Evelyn Alexander and Robert Charlie.

Extension Ideas:

1. Students can find photographs of the local area and label them to illustrate the hydrologic cycle.
2. Students can research use of hydropower in small communities in Alaska and in the western contiguous United States.

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Answers:

STUDENT WORKSHEET: "The Hydrologic Cycle in _____."

Team members: _____

The assignment will be assessed using the following rubric:

Element	Excellent 5/4	Satisfactory 3/2	Needs Work 1/0
The Picture Score_____	All required components are present and some additional components have been added. ☐ ground cover like plants and trees ☐ water source like lakes, rivers or snow ☐ clouds ☐ topographic features like hills, valleys, marshes, mountains ☐ buildings and/or roads (optional) The season of the year is evident. ☐ Winter ☐ Summer Drawing clearly depicts the local area and is neatly done.	All required components are present. ☐ ground cover like plants and trees ☐ water source like lakes, rivers or snow ☐ clouds ☐ topographic features like hills, valleys, marshes, mountains ☐ buildings and/or roads (optional) Drawing clearly depicts the local area.	Not all required components are present. ☐ ground cover like plants ☐ ground cover like plants and trees ☐ water source like lakes, rivers or snow ☐ clouds ☐ topographic features like hills, valleys, marshes, mountains ☐ buildings and/or roads (optional) Drawing is not clearly identifiable as the local area.
The Illustration of the Hydrologic Cycle Score_____	All necessary phases are present, correctly and neatly labeled. ☐ evaporation and/or sublimation ☐ transpiration ☐ condensation ☐ precipitation ☐ infiltration ☐ runoff	All but one of the necessary phases is present or one phase may be incorrectly labeled ☐ evaporation and/or sublimation ☐ transpiration ☐ condensation ☐ precipitation ☐ infiltration ☐ runoff	The illustration is missing more than one phase and/or phases are not labeled or are incorrectly labeled. ☐ evaporation and/or sublimation ☐ transpiration ☐ condensation ☐ precipitation ☐ infiltration ☐ runoff
The Presentation Score_____	Both teammates participate equally in the presentation. Explanations of depictions are clearly articulated. Reasoning is clear regarding phase labels.	Both teammates participate in the presentation, though one may speak more than the other. Teammates may need prompting to clarify explanations of depictions and phase labels.	At least one teammate participates in the presentation. Explanations of depictions and phase labels are unclear even after prompting.

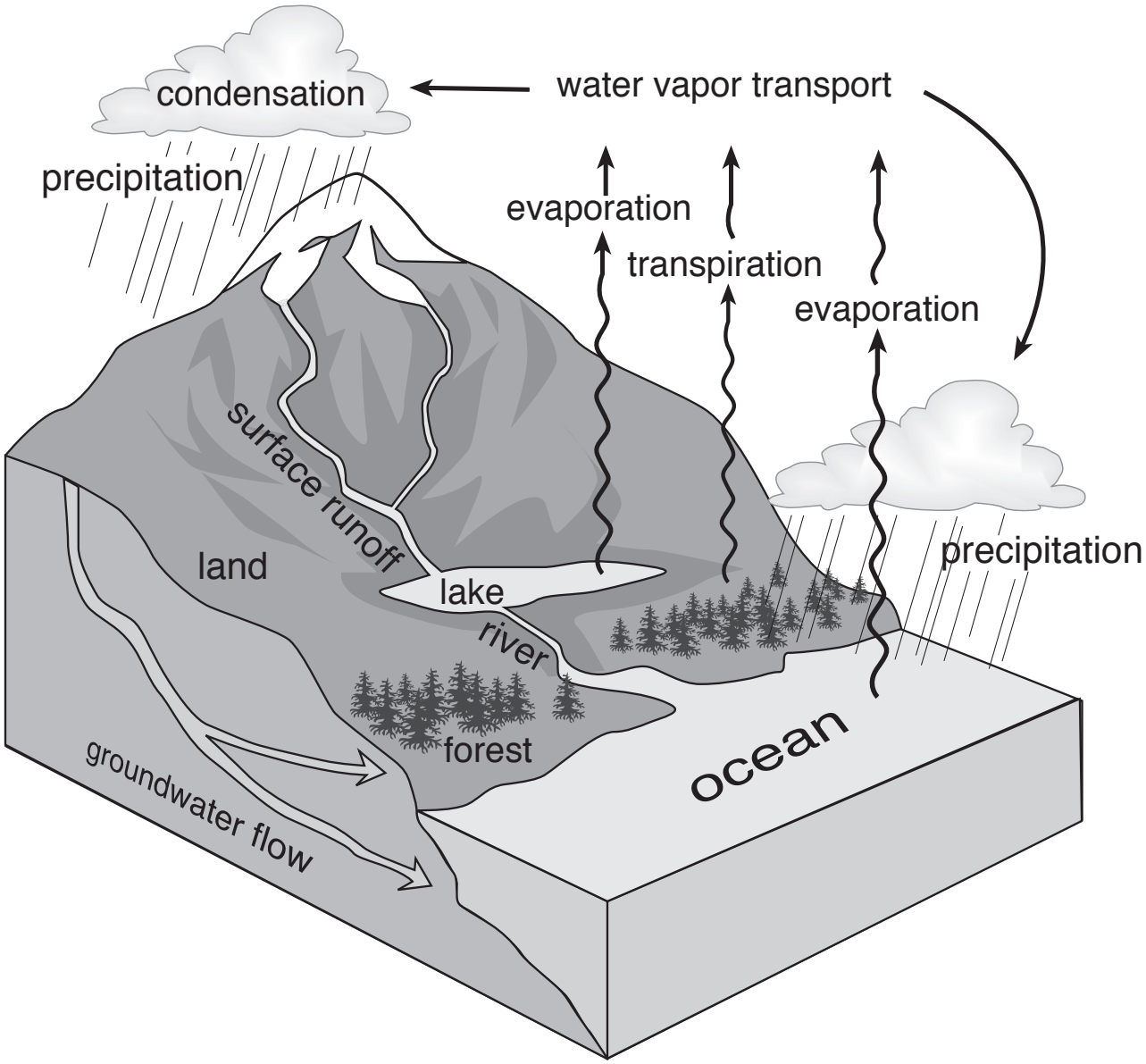
Additional Comments: _____

_____

STUDENT WORKSHEET: "Hydrokinetic Potential in _____."

1. hydro
   water energy
2. Answers will vary. Responses may include river, well, creek or stream, catch basin
3. Answers will vary. Responses may include tooth brushing, bathing, drinking, flushing, clothes washing
4. Answers will vary. Responses may include fishing, travel (boat or snow machine) fish wheels, swimming
5. Answers will vary. Local river will be named.
6. The current of the river pushes the paddles of the fish wheel.
7. Hydrokinetic power or hydropower
8. Answers will vary. Responses may include anything that requires electricity (running a furnace, powering lights, appliances, computers)

HYDROLOGIC CYCLE



NAME: _____

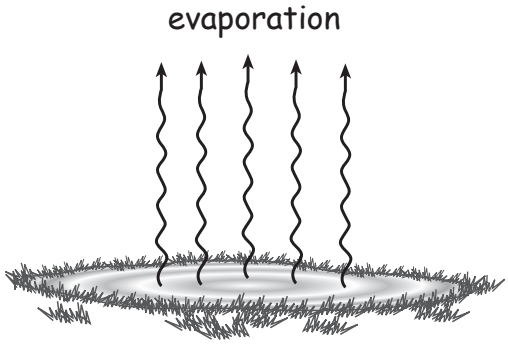
THE HYDROLOGIC CYCLE IN _____

Instructions:

You and a teammate will draw a picture of _____ and the area around it. You will use your picture as the basis for an illustration of the hydrologic (water) cycle as it occurs in _____. Once you and your teammate have completed the drawing the two of you will explain your illustration to the rest of the class. The three parts of this assignment are:

1. The picture of the community and the surrounding area. You and your teammate may draw the area either in winter or in summer. Essential items to include are plants, at least one water source (stream, lake, snow) and clouds. Show hills, mountains, marshes and valleys. You may include buildings and/or roads if you have time. It might be helpful to think of how the area might look if you were coming in on an airplane, rather than looking at it from ground level.

2. The illustration of the hydrologic cycle. Discuss with your teammate how the hydrologic cycle occurs in your area. Use arrows on your drawing to show the following phases of the hydrologic cycle: evaporation and/or sublimation, transpiration, condensation, precipitation, infiltration. Label each arrow with the phase of the hydrologic cycle illustrated. See the example below.



3. The presentation of the illustration. With your teammate explain your illustration to the rest of the class. Name the important elements of the drawing of the area you made and the season of year, then explain your reasons for labeling the phases of the hydrologic cycle as you did. For example, you might say that you labeled the arrow over a lake "evaporation" because water turns to vapor over the large body of open water.

Both teammates are expected to participate in the presentation.

The assignment will be assessed using the rubric on the next page.

NAME: _____
THE HYDROLOGIC CYCLE IN _____

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The Picture Score_____	All required components are present and some additional components have been added. ☐ ground cover like plants and trees ☐ water source like lakes, rivers or snow ☐ clouds ☐ topographic features like hills, valleys, marshes, mountains ☐ buildings and/or roads (optional) The season of the year is evident. ☐ Winter ☐ Summer Drawing clearly depicts the local area and is neatly done.	All required components are present. ☐ ground cover like plants and trees ☐ water source like lakes, rivers or snow ☐ clouds ☐ topographic features like hills, valleys, marshes, mountains ☐ buildings and/or roads (optional) Drawing clearly depicts the local area.	Not all required components are present. ☐ ground cover like plants ☐ ground cover like plants and trees ☐ water source like lakes, rivers or snow ☐ clouds ☐ topographic features like hills, valleys, marshes, mountains ☐ buildings and/or roads (optional) Drawing is not clearly identifiable as the local area.
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NAME: _____

HYDROKINETIC ENERGY POTENTIAL IN _____

Instructions: Respond to the prompts about real and potential uses of water in your community.

1. Reviewing what you know about the water cycle, which part of the word "hydrologic" ("hydro" or "logic") do you think refers to water? _____

   The word "kinetic" means energy created by something's motion or movement.

   What do you think the word "hydrokinetic" means? _____

2. Read the following real life water facts about three Alaskan communities, then answer questions about your community.

   Teller's municipal storage tank is filled during the summer by truck. Coyote Creek serves as the source for the school's water tank. Total storage in Teller is 1.1 million gallons. Teller's 2005 population was around 260.

   White Mountain's municipal supply is a well. Its municipal tank holds 150,000 gallons. Water is piped to most households. White Mountain has about 220 residents (2005).

   Shishmaref, sitting on a small island, has limited freshwater resources. The "washeteria," with a central watering point is supplied from a lined catch basin in which snow is captured with the help of snow fences during the winter. 300,000 gallons of storage is available. Water is either hauled by residents or delivered to tanks at the individual homes. Shishmaref has around 580 residents (2005).

   Elder Evelyn Alexander tells how water used to be obtained in the winter.

   > "*Tsitle tu'* means snow water. We taught the kids to dig to the bottom to get the snow there. Yeth uga', bottom snow. Kind of little bigger than the top snow. You fill up a bucket like this, the water will be this much for the top snow. But if you get the bottom snow the water will be almost full. More water comes out of the bottom snow. Anyway they used to say clear water, cleaner than top snow.
   >
   > All winter we used snow water. Springtime come we use water, but sometimes we go around in canoe we look for snow drift. We get snow. We save it for drinking water until no more snow, until in June. Sometimes late June. Out in camp. We stay out in camp. They make cellar and they keep snow in the cellar. Tanana River, when ice move we put ice to shore. We cut them up and haul back to our house. Most of the people used to have cellar. We keep ice there. *Òut tso k' a drighila* means ice cellar
   >
   > Sometime when the water come it is a little bit muddy, you know. Lots of little grass, gotta settle them. Lots of little bugs sometimes. We have to boil them and settle it. I haven't seen that for a long time. We don't do that no more. If I move I'll take that snow, maybe I'll save ice. We get ice too. Clear water. Snow water, *tsitl tu'*. We use that for tea and drinking. It tastes better than well water."

   In your community, where does water for daily use come from? _____

3. Name at least three things that everyone in your community uses water for every day.

   _____ _____ _____

4. Other than everyday uses by community members what are two other uses that water has in your community?

   _____ _____

NAME: _____
THE HYDROLOGIC CYCLE IN _____

Elder Robert Charlie of Minto tells the following story about water and rivers in and around his community:

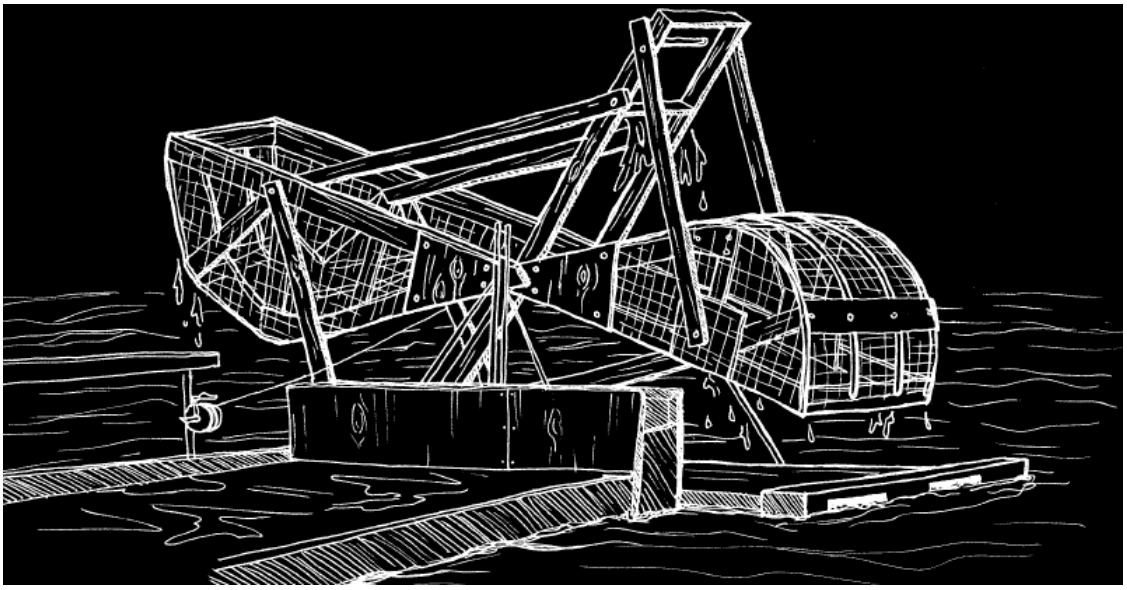
> "You got to have water when you're out hunting. Out from Minto when we go out traveling in the high country we never camp on top of those high ridges because there is no water there. You go down to a lower level where you can find puddles from rain or where the water has come up from the permafrost underneath. If you can't find water you can do like the animals do and kick a hole in the moss with your foot. In a little while that hole will fill up with water and you can use that to make your tea. Our ancestors learned how to do that from watching the animals. Another thing is you can look down from the top of one of those ridges and see a patch of willows and you know that a creek is there and you can find water. But you don't want to get water out of any place where there is beavers, because they make the water bad. But they're good to eat if you cook 'em the right way.
>
> If you are hunting or traveling in the wintertime you have tea then go a long time 'til you stop and rest. Then you melt snow and make tea and rest and drink as much as you can. Then you don't stop again until you get where you are going. You don't eat snow, though it is water. Snow makes you tired and makes you more thirsty. If you are chasing a moose and you see that moose licking snow up you know you are gonna get him because he is tired. If a moose leaves a hoof mark on the snow and doesn't sink in and make a hole you know he is saying, "You'll never catch me!"
>
> If you stand on top of one of those high ridges you can see how all the water is connected. Where you are is the headwaters of a little creek and that flows into a bigger stream like the Goldstream then they flow into bigger sloughs like the Chena and rivers like Chatanika and Tolovana , then it all comes down to the Tanana, then to the Yukon and that runs all the way to the ocean. It's all connected."

5. Many communities in Alaska are located on or near rivers. What is the name of the river nearest your community? _____

   How far from your community is the river?_____

6. Many Alaskans are familiar with the use of fish wheels. Look at the drawing of the fish wheel below. How does the fish wheel turn? _____

   _____



NAME: _____
THE HYDROLOGIC CYCLE IN _____

7. What type of energy powers the turning of the fish wheel? _____

8. Hydrokinetic energy or hydropower is one of the oldest sources of energy. It was used thousands of years ago to turn a paddle wheel for purposes such as grinding grain or as you have just determined, for turning a fish wheel. The amount of available energy in moving water is determined by how much of it there is (volume) and how fast it moves (velocity). Swiftly flowing water in a big river, like the Yukon River which flows from Canada, through the Yukon territory, down through Alaska and into the Bering Sea, or Columbia River that forms the border between Oregon and Washington, carries a great deal of energy in its flow. Water descending rapidly from a very high point, like Niagara Falls in New York, also has lots of energy in its flow.

   In either instance, the water flow is directed through a pipe, or penstock, then pushes against and turns blades in a turbine to spin a generator to produce electricity. In a **run-of-the-river system**, the force of the current applies the needed pressure. In a **storage system**, water is accumulated in reservoirs created by dams, then released as needed to generate electricity.

   If there was a way to capture the same energy that turns the fish wheel and use it to turn the blades of a turbine to spin a generator, what uses could your community make of the power that was generated? List at least two.

   _____

   _____

   _____

   _____