Plunging Into the Water Cycle

Grade 4 *'Ōhi'a Project / Exploring the Islands*

Lesson at a Glance

Students conduct experiments to enhance their understanding of endothermic and exothermic reactions, evaporation, transpiration, infiltration, and condensation.

Key Concepts

- Water is found in three states: liquid (water drops, clouds, fog, and precipitation in the form of rain), gas (water vapor), and solid (precipitation in the form of snow or ice).
- Water is continually cycled between the atmosphere and the Earth's surface and is affected by temperature, topography, vegetation, and geology. Water is not lost.
- When water changes state, the phase is either an endothermic (heat absorbing) or exothermic (heat loss) reaction.
- Water reaches the Earth as precipitation and runs off as surface water, infiltrates the ground to become groundwater, or is intercepted by vegetation. It returns to the air through the combined processes of evaporation through plants, land and ocean surfaces.

Essential Questions

- What factors affect the water cycle on high volcanic islands?
- How are high islands like water factories?

Hawai'i Content Performance Standard III, Science

Strand		The Scientific Process	
Standard 1: The Scientific Process: SCIENTIFIC INVESTIGATION: Discover, invent, and investigate using the skills necessary to engage in the scientific process.			
Topic		Scientific Inquiry	
Benchmark SC.4.1.1		Describe a testable hypothesis and an experimental procedure.	
Sample Performance Assessment (SPA)		The student: Describes a testable hypothesis (e.g., if, then, because statement) and an experimental procedure to test it.	
Rubric			
Advanced	Proficient	Partially Proficient	Novice
Create a testable hypothesis and an experimental procedure to test it.	Describe a testable hypothesis and an experimental procedure.	Identify, with assistance, a testable hypothesis and an experimental procedure.	Recognize, with assistance, a testable hypothesis or an experimental procedure.

Hawai‘i Content Performance Standard III, Science, Grade/Course: Physical Science

Strand		Physical, Earth, and Space Sciences	
Standard 6: Physical, Earth and Space Science: NATURE OF MATTER AND ENERGY: Understand the nature of matter and energy, forms of energy, and energy transformations, and their significance in understanding the structure of the universe.			
Topic		Energy and its Transformation	
Benchmark SC.PS.6.1		Describe endothermic and exothermic chemical reactions (*use water in the water cycle as an example*).	
Sample Performance Assessment (SPA)		The student: Gives examples of endothermic and exothermic reactions (*use water in the water cycle as an example*).	
Rubric			
Advanced	Proficient	Partially Proficient	Novice
Determine and justify logical connection(s) and implications among hypotheses, scientific evidence, and conclusions.	Determine logical connection(s) among hypotheses, scientific evidence, and conclusions.	Identify some connections between hypotheses, scientific evidence, or conclusions.	Make unsubstantiated connection(s) among hypotheses, scientific evidence, and conclusions.

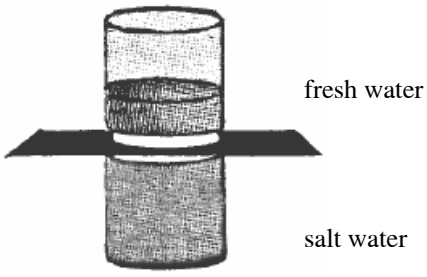
Objectives
Students:
- Place “water factory” puzzle pieces on an island illustration to show how our high islands are like water factories. Write summaries using vocabulary to explain how each puzzle piece contributes to the water cycle and describe how the water is affected by temperature, topography, vegetation, and geology as it moves through the cycle.
- Illustrate or mark a water cycle diagram with labels for condensation, precipitation, infiltration, groundwater lens, water table, runoff, transpiration, and evaporation.
- Describe the three states of water as it passes through the water cycle.
- Complete a report on a water cycle experiment that explains the question/problem, investigation design, observations/findings, and conclusion.

Exploring the Islands Telecast: “Take a Water Cycle Ride”
Students from Kūhiō Elementary School conduct demonstrations and make a large island “water factory.” A magical water cycle “ride” further develops understanding of the water cycle in the islands. During the program, students will illustrate the rainfall gradient, conduct a demonstration of fresh water floating on salt water, and use “water factory” pieces to show how high islands are like water factories.

Time
five to six class periods

Subject Area
science

Materials/Resources
water cycle diagram, labeled and blank (provided)
water cycle crossword puzzle (provided/optional)
student activity sheets (provided)
clear glass or plastic bowl



The density of salt water vs. fresh water is demonstrated on *Exploring the Islands*.

2 dark-colored pie tins or bowls
3 strips of same colored construction paper (2 in. by 6 in.)
transparent tape
zipper plastic bags, sandwich size
3 cans (same size), tops and bottoms removed
measuring cups and spoons
tall clear glass cup with ice and cold water
digital projector and computer (optional)
overhead projector (optional)
1 transparency sheet if using overhead projector (optional)
electric fan (optional)

During the *"Exploring the Islands"* telecast:

For each student:

- paper, pencil, eraser
- illustration of mountain and water factory pieces (provided)

For class demonstration:

- pitcher of water colored with food coloring and ice to chill the water

For each team of approximately four students:

- a clear jar (baby food size) or plastic cup of water colored blue
- a clear jar (baby food size) or plastic cup of water colored red
- stiff piece of paper to place between jars if using jars
- eye dropper or spoon if using plastic cups
- salt (approximately 2 tablespoons)
- paper towels to wipe up spills

Preparation

For the *Exploring the Islands* telecast, prepare a condensation demonstration. Fill a pitcher with water, add a few drops of food coloring and have some ice ready.

In the early morning when there is still dew on the ground, place a clear glass or plastic bowl upside down in an open area on the grass. If more than one bowl is used, place the others over different types of surfaces such as concrete or soil. Be sure the bowls are flush to the ground so that moisture can't escape. Allow the bowls to sit in the sun at least an hour before beginning the lesson.

If you have access to a computer, digital projector, and scanner, scan the water cycle diagram and project it to the class. If you are unable to project images from your computer, copy the water cycle diagram onto a transparency sheet to use with an overhead projector. You may also make multiple copies of the water cycle diagram and pass it out to students.

Vocabulary

Endothermic, exothermic, evaporation, condensation, precipitation, infiltration, transpiration, evapotranspiration, fog drip, runoff, infiltration, groundwater lens, water table, freshwater lens, dikes, surface water, surface runoff, caprock

Teacher Background Information
The water cycle is the continual movement of water evaporating, rising, cooling, and forced up cliffs. During this cycle, water is found in three physical states: liquid (rain, water drops, clouds, and fog), gas (water vapor), and solid (ice, snow). Water goes through endothermic or exothermic chemical reactions as it changes states in the water cycle. In **endothermic** reactions, heat is absorbed. In **exothermic** reactions, heat is given off. In the water cycle, water is not "lost" but is continually recycled as it changes form.

Evaporation occurs when water such as from our ocean changes from its liquid state to its gaseous state, or vapor, due to the absorption of the sun's heat. This phase is an endothermic reaction. Air rises up the mountain cliffs where it cools as it rises. When water is in the **condensation** phase, water vapor in the air cools, heat is lost and water then changes from a gas state to a liquid state. The water vapor condenses into tiny visible droplets of water, which we see as clouds. Condensation is the reverse process of evaporation and this phase is an exothermic reaction due to the loss of heat. In these clouds, water droplets may join other droplets, becoming larger and larger until the air cannot support their weight. These drops then fall out of the clouds as **precipitation**, or rain. This type of rain is called orographic (mountain-caused) rainfall. If the air were cold enough, the drops would change from a liquid state to a solid state such as ice or snow. The crystallization or freezing effect of water, which occurs at night at the top of Mauna Kea, is an exothermic reaction. When the ice or snow melts, we have an endothermic reaction because heat from the sun is being absorbed.

Plants contribute water to the water cycle through **transpiration**. Transpiration, a form of evaporation, is the transfer of water from the pores on leaves to the atmosphere. **Evapotranspiration** is the evaporation of water from soil and transpiration. Evapotranspiration is greater in dry seasons or dry areas compared to wet seasons or wet areas. In wet areas or wet seasons, showers and humidity reduces transpiration.

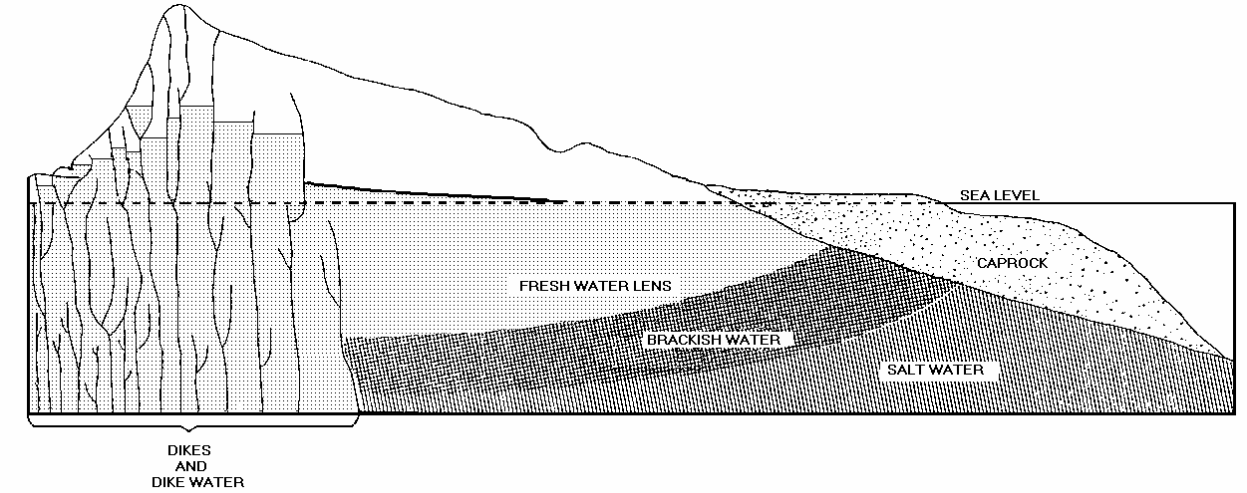
Fog drip, a form of condensation, occurs when vegetation and tall trees intercept moisture from passing clouds or fog. The moisture condenses on the vegetation and trees and eventually drips into the ground, recharging the groundwater below. Some of the water that drips to the ground is used by the underlying vegetation. Fog drip can be a significant contributor to rainfall in places that might not otherwise have high rainfall such as on the island of Lāna'i. To supplement the rainfall on Lāna'i, Cook pines were planted at the summit of Lāna'ihale. The redwood forest of California is also known for its ability to produce fog drip. Redwoods are one of the tallest trees in the world—91.5 m (300 ft) tall—and can live to be more than 2,000 years old. The vegetation and wildlife under the redwoods depend on the water from fog drip for their survival. Environmentalists consider fog drip a good reason to stop the logging of forests. Fog can supplement water during dry summers. In other parts of the world where there is little rain but much fog, a significant amount of the water supply comes from fog drip. In arid environments in countries such as Chile, Ecuador, Peru, and South Africa, people collect water by setting up fog collectors using mesh screens that look like volleyball nets. The mesh screens intercept the fog and the water drips down to a storage container.

Some of the rain that reaches the ground becomes surface **runoff**, which is the transfer of water on land to the ocean via lakes, streams, and rivers. **Infiltration** occurs when water percolates

through the soil and permeable volcanic rock. Permeability is the measure of how easily water moves through the rock or soil. Factors such as urban development and impermeable soil encourage runoff. Many people commonly equate rainstorms to mean more water for us to drink and use. However, most rainfall in Hawai'i becomes surface runoff during intense rainstorms. During rainstorms, the rate of infiltration is slower than the rate of surface runoff. This is because soils have maximum rates of infiltration and if the rate of rainfall exceeds that, the rain becomes surface runoff. Moderate rainfall evenly spaced throughout the year is preferable to intense rainstorms of limited duration. That is why during times of drought, water levels do not necessarily return to normal after rainstorms.

Water that collects in lakes, rivers, ponds, streams, and other bodies of water is referred to as **surface water**. In Hawai'i, surface water is used mostly for agriculture.

Much of the water that infiltrates the ground will eventually reach the **groundwater lens**, a lens-shaped body of fresh water deep within each island. In Hawai'i, most of the residential drinking water used by people comes from groundwater. Smaller volumes of groundwater trapped between layers of porous and less porous material is called perched water. Below sea level the volcano is saturated with water. Since fresh water is slightly less dense than salt water, the fresh water floats on the salt water. The top of this layer of fresh water is called the **water table**. For every meter (about 3 ft) of fresh water above sea level, there will be about 40 m (131 ft) below sea level. There is a zone of brackish water at the bottom of the lens where the fresh water and salt water mix. The mechanics of this groundwater lens were first identified by two scientists—Ghyben and Herzberg. The **freshwater lens** is now called the Ghyben-Herzberg lens. On Hawai'i Island, one of the greatest Ghyben-Herzberg lenses exists in the Hilo region.



Groundwater is also stored between sheets of nearly vertical dense rock called dikes. Dikes are formed when magma fractures its way from the magma chamber to a vent on the surface of the volcano. Some of the magma stays behind and solidifies in the fracture. This is what we see today as a dike—sheets of dense, relatively impermeable rock, which tend to hold water between them. Between the dikes are older lava flows, which are porous and permeable. Dikes range from several centimeters to 15 m thick (1 in to 49 ft). Most dikes are between 0.3–1 m (1–3 ft) thick. When tunnels are bored into a dike compartment, millions of gallons of water per day can be

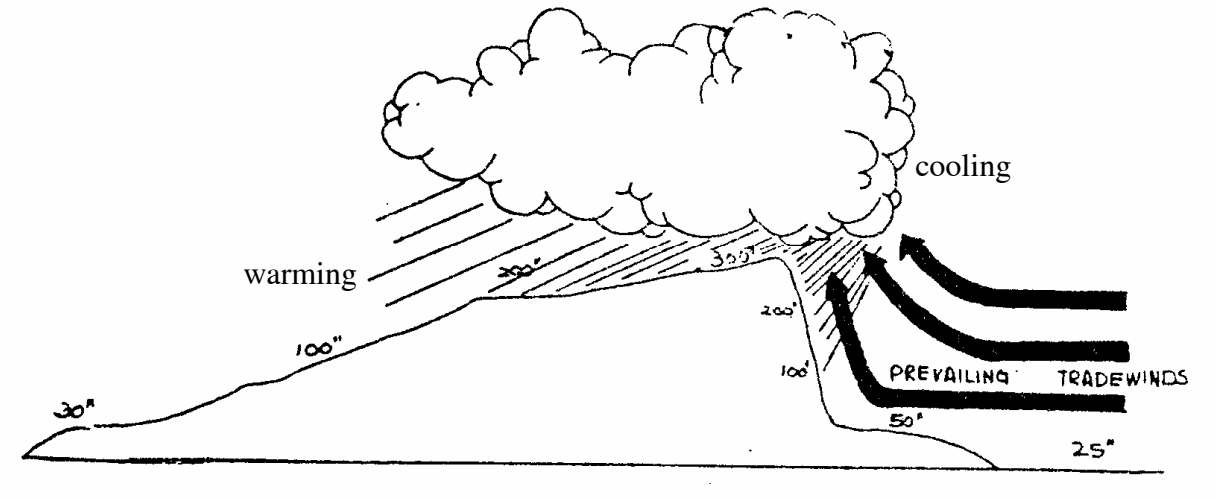
added to the public water supply. When a stream cuts into a dike, natural springs may form in the mountains high above the water tables of the fresh water lenses.

Caprock is formed when alluvial (stream) material from valleys and marine sediments deposit on the plains. Caprock is found on flat areas near the shore on older islands where reefs have a chance to form. It can be more than 300 m (1,000 ft) thick in some places, extending well below the current sea level. Since caprock is relatively impermeable, it retards the movement of groundwater from the freshwater lens to the sea and of sea water into the lens. Younger islands with relatively little caprock, have many low-tide springs where the shallow lens leaks into the sea. Wading or swimming along the coast in these areas, you can feel the cold springs seeping into the seawater. In old Hawai'i, divers captured some of this fresh water in gourds and brought it to the surface for drinking.

Fresh water is contained under pressure behind caprock. This water will often escape through the caprock, both below sea level and on land, as springs. This pressurized water can also be released into wells drilled through the caprock.

Terrain is the "fine tuner" of local weather, shaping, lifting, distributing, blocking, and adding velocity to the normal trade winds. Rainfall in Hawai'i is mostly orographic and fairly distributed throughout the year in windward and mountain areas. In the dry leeward areas, rainfall is seasonal and it is not uncommon for these areas to get much of their rain from large winter storms.

Where the mountains are higher than 1,800 m (6,000 ft)—such as Mauna Loa, Mauna Kea, and Haleakalā—most of the rain falls on their windward side between 600–1,525 m (2,000–5,000 ft)



Orographic (mountain-caused) rainfall on a mountain between 2,000 and 5,000 ft in elevation. Rainfall increases up the windward slopes as air is forced over the summit and decreases as the air descends and warms on the leeward side of the mountain.

elevation. Usually a layer of warm air, called the inversion layer, keeps the moisture below it. On the summits of these very high mountains there are alpine deserts where temperatures are cold and very little rain falls.

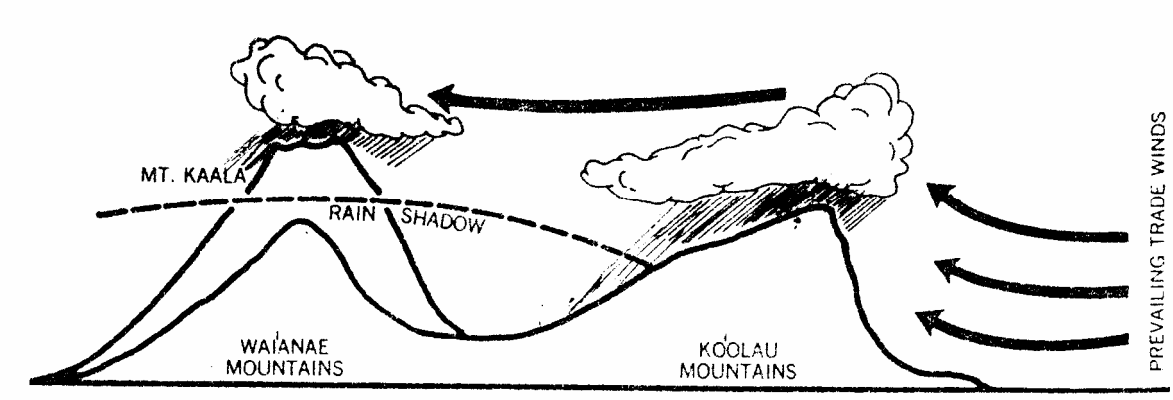
When it rains in our islands, some of the water finds its way to our watersheds. **Watersheds** are land areas that drain to a particular body of water. For instance, a watershed is any area of terrain that slopes from its natural boundaries in such a manner that rainfall in that area will eventually run down into a stream or river that drains the area. It could be a mountain forest where water drains into a stream. Watersheds can include people's lawns, parking lots, and streets. Sometimes small watersheds join together to form even larger watersheds.

In the Hawaiian language, there are many names for the different types of ua (rain) that are characteristic of valleys, ridges and summits. For example, *ua hehi pua hala o Po'oku* ("the rain that treads on the pandanus flowers of Po'oku"). Similarly, there are many Hawaiian names for *makani* (wind). Pāka'a contained the winds in a special gourd. He taught his young son, Kū a Pāka'a, the wind chants, and according to one *mo'olelo*, Kū was able to call out more than 100 wind names for places in the islands. (Look up the words *ua* and *makani* in Mary Kawena Pukui and Samuel H. Elbert, 1986 ed., *Hawaiian Dictionary*, Honolulu, University of Hawaii Press). Also, for a compilation of winds and rains of Hawai'i, refer to page 132 of Nakuina, Moses K., *The Wind Gourd of La'amaomao*, Honolulu, Kalamakū Press, 1990.

Samples of Hawaiian *'ōlelo no'eau* (proverbs) about different types of rain (see Pukui, *'Ōlelo No'eau* for additional proverbs):

Ka ua hō'eha 'ili o Waiehu.
The skin-hurting rain of Waiehu. (a chilly, pelting rain)

Ka ua kani ko'o o He'eia.
The rain of He'eia that sounds like the tapping of walking canes. (also said of rain in Hilo)



The Ko'olau Mountains on O'ahu create a wind and rain shadow on the leeward side of the island and receive most of the water vapor delivered by the northeast trade winds.

Ka ua kea o Hāna.
The white rain of Hāna. (refers to the misty rain of Hāna, Maui, that comes in from the sea)

Ka ua Kīpu‘upu‘u o Waimea.
The Kīpu‘upu‘u rain of Waimea, Hawai‘i Island. (When Kamehameha organized an army of spear fighters and runners from Waimea, they called themselves Kīpu‘upu‘u after the cold rain of their homeland.

Ka ua Kūpunikapa o Lanakila.
The hold-fast-to-the-clothing rain of Lanakila. (The rain of Lanakila, Maui, is so cold that it makes one clutch and hold clothing close to the body.)

Sometimes a mountain casts wind and rain "shadows" on other mountains or islands. On O‘ahu, the Ko‘olau Mountains are in the path of the northeast trade winds and the Wai‘anae Mountains are in the rain shadow of the Ko‘olau Mountains, so the Wai‘anae Mountains receive much less rain. Kaho‘olawe is in the rain shadow of Haleakalā on the east side of Maui while Lāna‘i is in the rain shadow of the West Maui Mountains. Ni‘ihau lies in the rain shadow of Kaua‘i.

On Hawai‘i Island, the Kona Coast is in the rain and wind shadow of Mauna Kea, Hualālai, and Mauna Loa. Normally the trade winds go around those mountains. During unusual conditions, trade winds may go over the mountains and descend many miles out to sea. The winds in Kona, Hawai‘i are generally caused by the land warming up faster than the sea during the day and cooling more rapidly than the sea during the night. During the day, sea breezes move upslope and at night land breezes move down slope to the sea.

Human activities on land can negatively affect our water supplies. After a heavy rain, surface runoff can include pollutants that eventually find its way to our beaches and ocean. Many industries are a major source of pollution and can have an affect on the environment and our water cycle. For instance, industrial pollution is a primary cause of acid rain. Acids are chemicals that can burn or eat away substances. Acid rain comes from air polluted with gases such as sulfur dioxide and nitrogen oxides. When it rains, the gases are diluted into acids, which in turn can kill forests.

Teaching Suggestions

1. Turn on a faucet in the classroom and allow some water to drip out. Ask students where the water comes from. Trace the path of a raindrop that falls on the island and ends up at that faucet.

2. Project the water cycle diagram and review it. Explain that evaporation increases when energy is added—the energy can either be from the sun or the wind.

3. Conduct a discussion on the three states of water, exothermic and endothermic reactions, and the water cycle.

   Discussion Questions
   - What are the three states of water? (*Solid, liquid, gas*)
   - In the water cycle, which water phases are endothermic and exothermic? (*Condensation and freezing are exothermic; evaporation and melting is endothermic.*)
   - What causes water to evaporate? (*Energy from the sun either directly warming the land and sea or indirectly by driving the wind.*)

- What causes water to condensate? (*Water vapor cools as it rises in elevation.*)
- Does the water on Earth ever get used up? (*No. It is continually recycled. We might be drinking water that passed through a dinosaur!*)
- Who needs water? (*Every living thing from a bacterium to a person to a koa tree.*)

During the *Exploring the Islands* Telecast
"Take a Water Cycle Ride"

***Mystery Minute* Question for This Week**

What large physical feature affects climate where you live?

***MindPower Minute* Questions**

- How could you make water vapor condense in your classroom? How is this process important for your life?
- Plot these four rainfall amounts on your island picture: 70 in, 350 in, 25 in, 10 in
- Use your factory pieces to show how an island is like a water factory.

Student Activities

- Draw and label a mountain to illustrate the rainfall gradient from the windward to the leeward side of a Hawaiian Island. Near the end of the program, label the groundwater lens on this drawing.
- Teams of students demonstrate how fresh water can float on top of more dense salt water. (See Materials/Resources listed above and have them ready.)
- Place water factory pieces on a mountain diagram to show how high islands are like water factories

Mahalo to . . .

Lanakila Elementary School for assisting with *Exploring the Islands*!
Teachers: Alyce Ikeoka and Dawn Waiwaiole
Students: Victor Cheung, Kanani Herring, Travis Hishinuma, Chalei Maduli

4. Divide the class into teams and distribute the materials they will need for *Exploring the Islands*. Have the pitcher with colored water and the ice available for a demonstration at the beginning of the program and watch the telecast. For more details, see box on the previous page.

5. After the telecast, take the class outside to the inverted bowl(s). Ask the students to interpret what they see (moisture is transpiring through and evaporating from the grass, and condensing on the inside of the bowl). If there are other bowls, compare what is happening in them. Cement or bare soil holds little moisture, so a bowl over these surfaces should be nearly dry. (As a rainy day option, conduct the experiment indoors using lamps and a well-watered terrarium.)

6. Ask teams of students to each investigate one of the following concepts: evaporation, transpiration, infiltration, or condensation. Distribute the student activity sheets and ask students to predict the circumstances under which these processes will be greatest, and then test their predictions with the following experiments:

A. Evaporation

Place one pie tin indoors and one outside. (Note that a dark-colored pie tin will absorb more heat than a light-colored one.) Place a stone in the pie tin outside to weigh it down. Pour one spoonful of water in each pie tin.

Wet the three strips of colored construction paper under a faucet and allow them to drain. Tape one strip indoors in a still, sheltered place. Tape another indoors in front of a fan or window, and the last outside in the sun. The students can watch the color of the paper strips change color as they dry.

Record the time each experiment is begun, and then observe how long it takes for the pans and paper to dry out. **Which pan will dry first? Is evaporation an endothermic or exothermic reaction? Why?**

(Expected results: Water in the pie tin outside should evaporate faster because the sun's evaporative energy is stronger outside. The wet paper in the sun and wind should be the first to dry, while the paper in a dark, sheltered place will remain damp much longer.)

In case of rain conduct the experiment indoors using a strong light or hair dryer as the sun.

B. Transpiration

Select an outdoor plant with small, easy-to-reach leaves that are exposed to bright sunlight. Carefully break off a few leaves, place them in a zipper plastic bag. Leave the bag out in the sun near the plant. Next, place another bag over a few leaves still attached to the plant. Zipper it closed. After half an hour check the bags. **Which bag has the most water? Is transpiration an endothermic or exothermic reaction? Why?**

(Expected results: The leaves attached to the plant should transpire more readily because they have access to water drawn in from the roots while the separated leaves have lost their water source.)

Note—some plants transpire more than others. You may have to lengthen the time of the experiment.

Students could try the experiment again on different types of plants and compare the results. (Plants that readily transpire include wedelia, impatiens and croton. Plants that transpire very little include cactus, pineapple, aloe and jade plants.)

In case of rain conduct the experiment indoors using potted plants.

C. Infiltration

Using the cans without tops and bottoms, push one into a grassy area not frequently walked on, another into bare, compacted soil and another over bare, loose soil beneath a bush. Pour a cup of water into each can. Firmly hold each can to the ground so that water does not leak out. Time how long it takes for the water to infiltrate the soil. If possible, repeat over similar areas on slopes. **Which area has the quickest infiltration? Why?**

(Expected results: Infiltration will be slowest on the bare, compacted soil because there is little pore space for the water to enter, and no roots to help cut a path. For the same reasons, infiltration will be quickest under the bush.)

In case of rain take the class outside to observe what happens to rain falling on a grassy area and a compacted pathway.

D. Condensation

Fill a tall clear glass cup with ice and cold water. Mark off the water level. Place in a warm area or outside in the sun for quick, maximum results. Initially observe how the glass feels: cold, dry. Wait a few minutes and check the glass. Feel the glass. How does it feel? Cold and wet. **Is condensation an endothermic or exothermic reaction? Why?**

If the glass is left in the sun, leave it overnight. What happened to the water level the next day? (Evaporation)

8. It will take students varying amounts of time to complete their experiments; the groups working on evaporation, transpiration, and condensation will have to wait at least half an hour to obtain results. During this time, write some of the *ʻōlelo noʻeau* about *ua* (rain) on the board and discuss them with students (see Teacher Background). Challenge students to write their own proverbs about rain in an area of your island.

9. When the experiments are complete, ask groups to share their predictions, results, and conclusions with the rest of the class, and visit each group's station to see the results. Be sure students understand that if they did their experiments correctly, there should be no right or wrong answers. If the results were not as expected, encourage them to suggest explanations.

10. Have students complete the assessment activities—the water factory illustrations, water cycle diagrams, and written summaries of their experiments.

Extended Activities

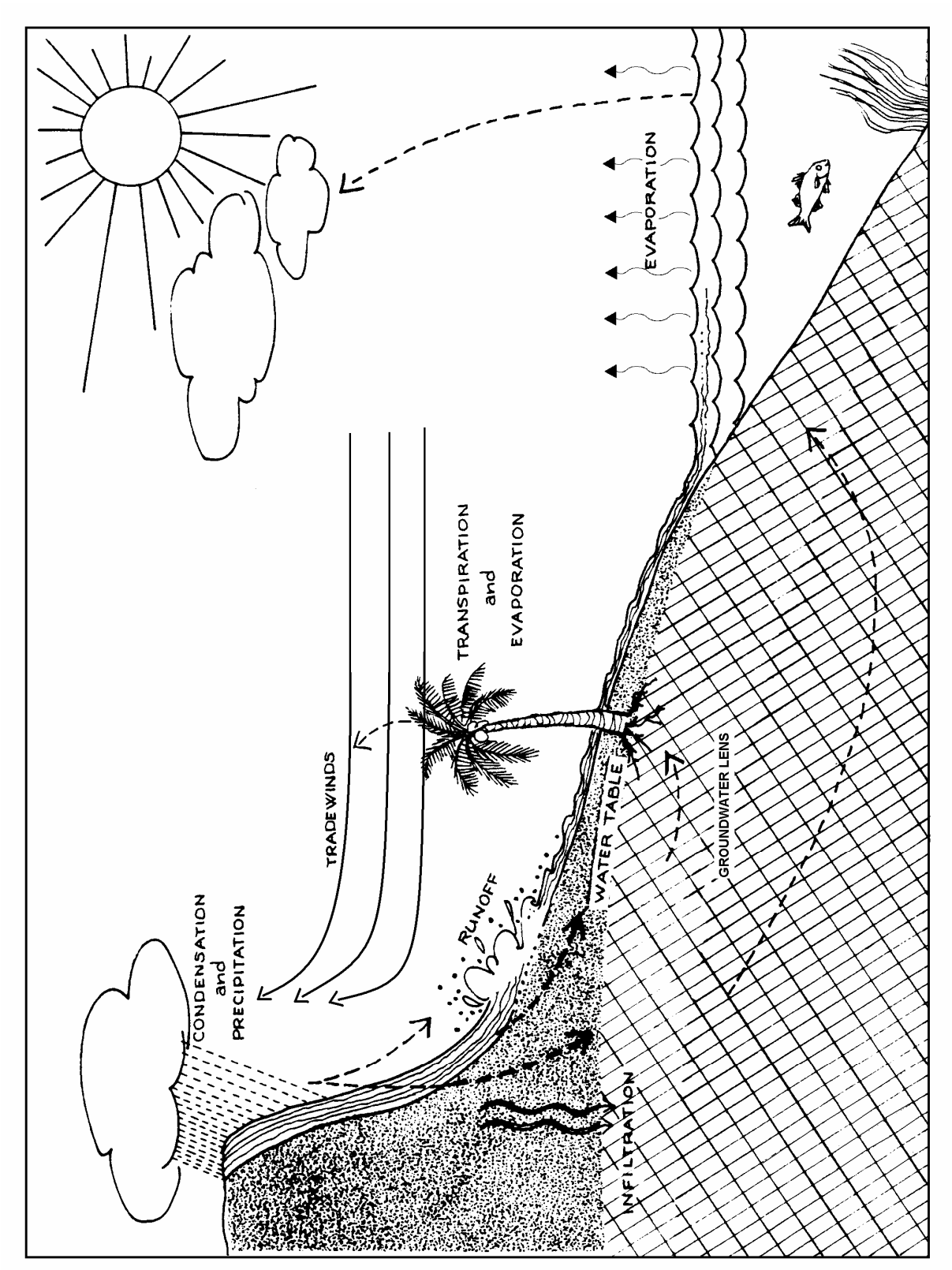
- Invite a *kupuna* to visit your class and share the Hawaiian names for the *ua* (rain) and *makani* (wind) in your area and other areas. Have students draw pictures that illustrate these names.

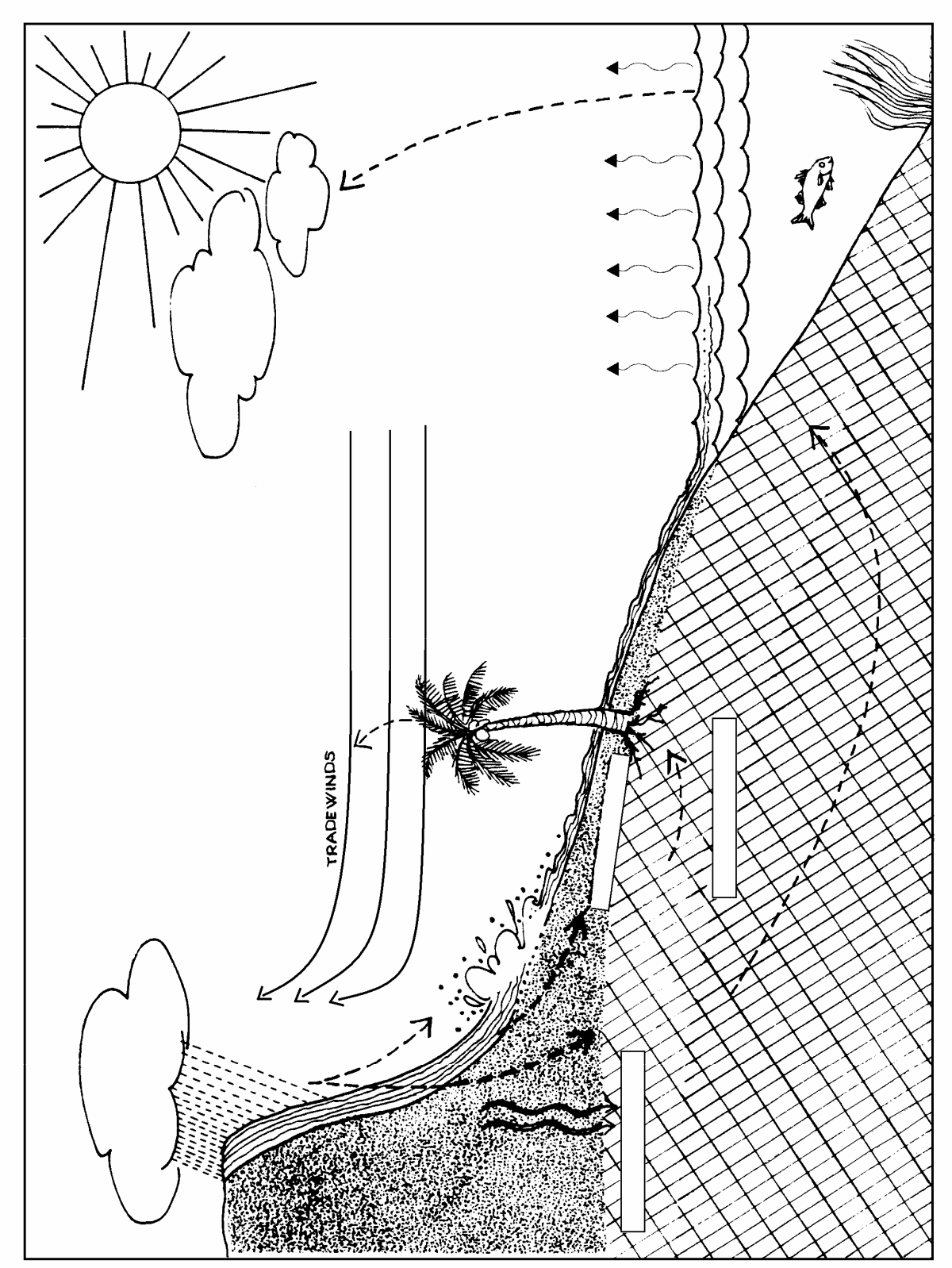
- A lot of surface water ends up as runoff into the sea. Invite students to design a system/device that could trap or capture the runoff before it goes into the sea. They may draw and label or build a model to show how this system works.

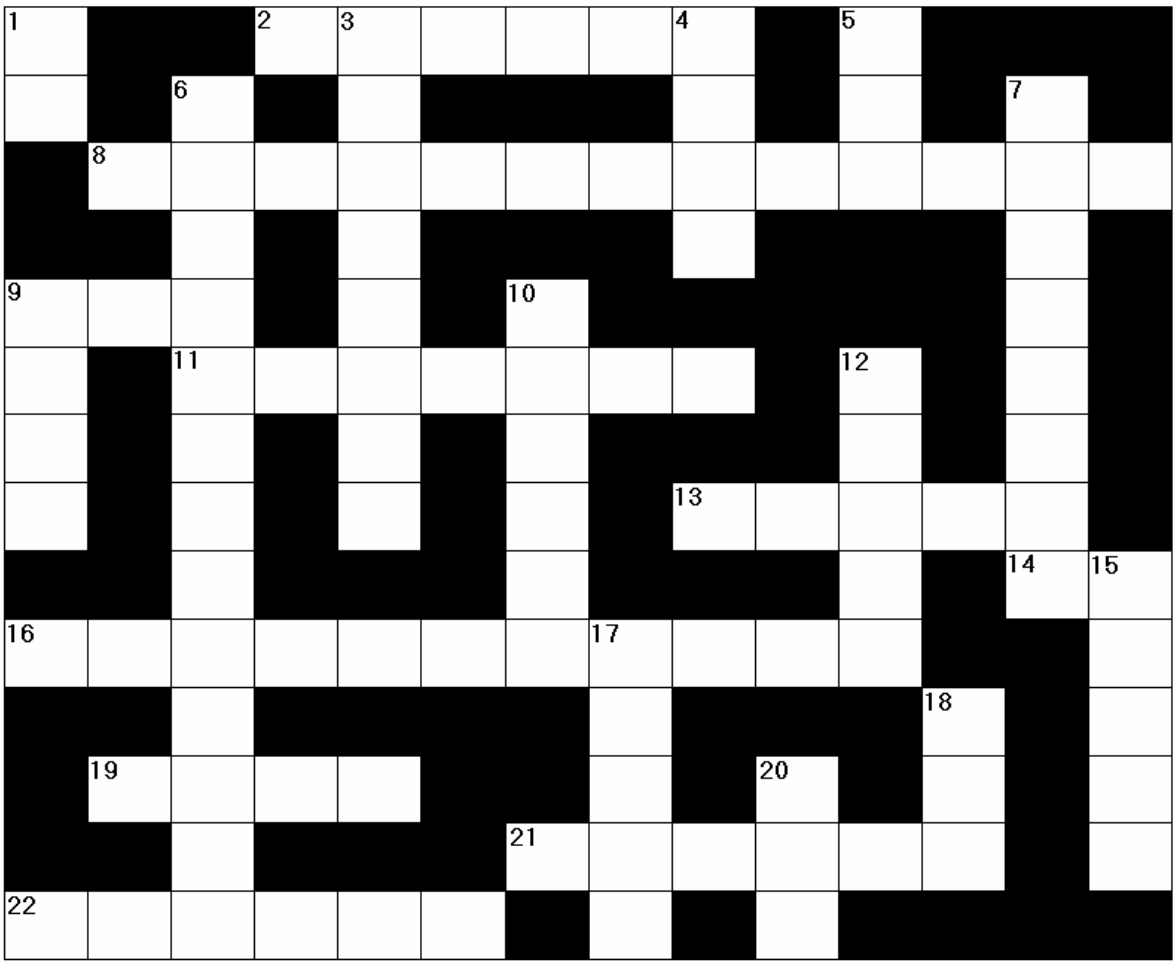
- Have students repeat their experiments later in the year, at a different time of day, or when the weather is different and compare the results.

- Have students create a mini-water cycle for the classroom. See the activity "Your Own Water Cycle" from "Wheel of Water," Grade 2, Humans and the Environment.

- Distribute the water cycle crossword puzzle to students to complete. Answers to the crossword puzzle are: Across: 2. ground, 8. precipitation, 9. sun, 11. surface 13. cools, 14. ed, 16. evaporation, 19. wind, 21. energy, 22 runoff; Down: 1. HI, 3. recharge, 4. data, 5. hot, 6. transpiration, 7. condense, 9. snow, 10. mālama, 12. blown, 15. drain, 17. think, 18. sky, 20. dry.


EVAPORATION
TRANSPIRATION
and
EVAPORATION
TRADEWINDS
CONDENSATION
and
PRECIPITATION
RUNOFF
WATER TABLE
GROUNDWATER LENS
INFILTRATION


TRADEWINDS



Across

2. Water that's held deep within the rocks is called _____ water.
8. The scientific term that describes rain, snow, fog, hail.
9. This provides the energy for the water cycle.
11. Water that flows over land in streams and rivers is called _____ water.
13. As air rises, it _____
14. Education (abbreviation)
16. The process of water being absorbed into the atmosphere by the sun's energy.
19. This force can speed up evaporation.
21. This is needed for evaporation to occur.
22. Water that flows into rivers and streams is called _____.

Down

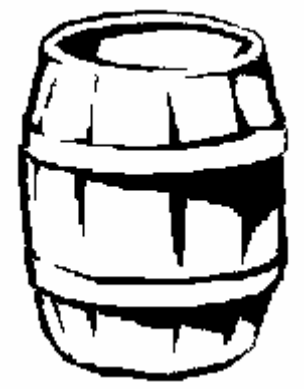
1. Hawai‘i (abbreviation)
3. Water that drains deeper than the deepest roots is said to _____ the water table.
4. To learn more about the weather, scientists and students must first collect _____.
5. This kind of air rises.
6. The process of plants releasing water.
7. As air cools, the moisture in it will _____.
9. On the peaks of Mauna Kea and Mauna Loa, precipitation often falls as _____.
10. This Hawaiian word means “to take care of, to care for, to preserve.”
12. Air is _____ by the trade winds up mountain slopes, where it cools, condenses and falls as rain.
15. Water is precious, so don’t let too much go down the _____.
17. People should always _____ before they act.
18. There are many different types of clouds in the _____.
20. The leeward sides of the Hawaiian Islands are often very _____.

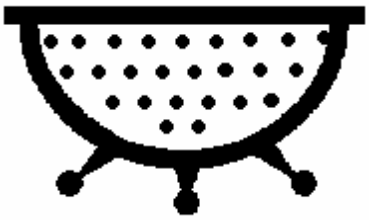
How is a high island like a water factory?

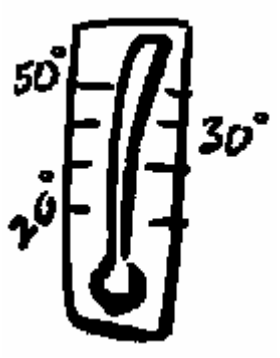
Cut out the "factory" pieces below and place them on the mountain illustration on the student activity sheet to show how this high island is like a water factory. Identify what each piece represents by writing one of the words from the word bank next to it:

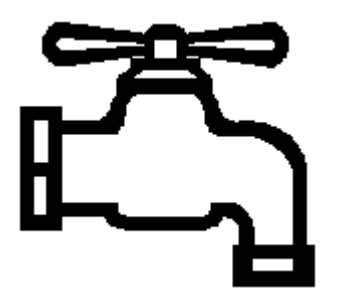
Word Bank: infiltration, dike compartments/groundwater, rain/precipitation, mountain high elevation, caprock, northeast trade winds

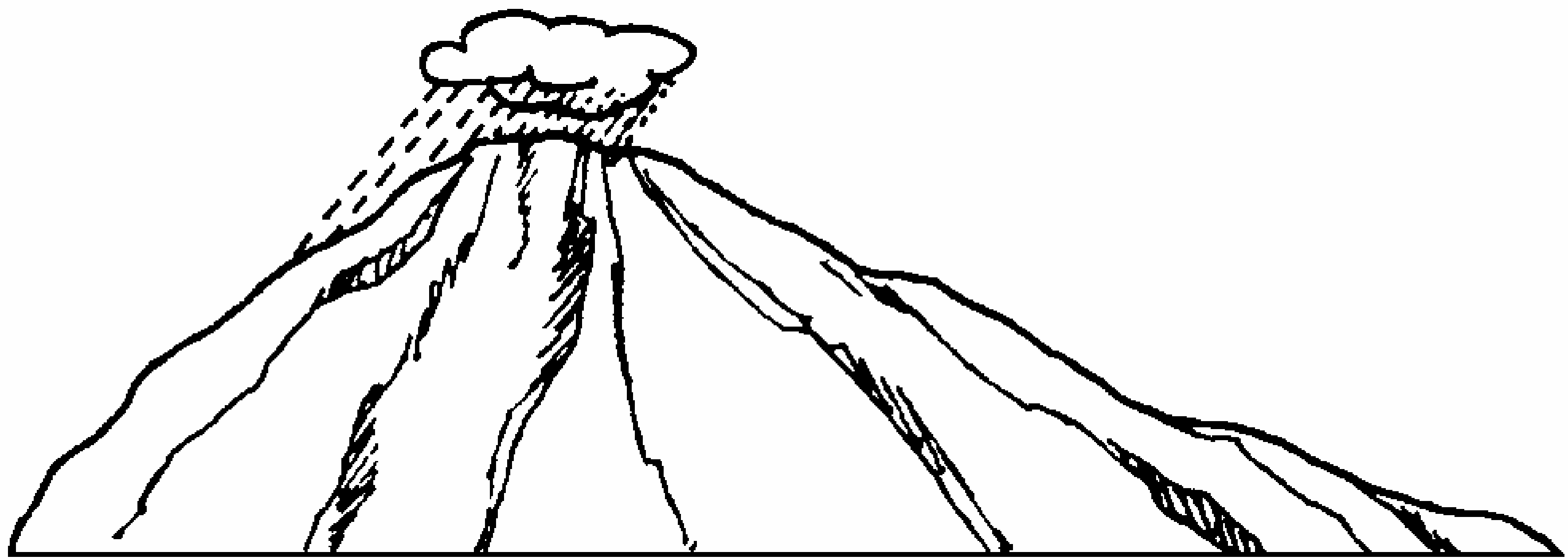
On the other side of the student activity sheet, write a brief summary that explains how this high island is like a water factory. Use each of the words from the word bank in your description. Include your ideas about how the water is affected by temperature, mountains, plants, and types of rocks as it moves through the cycle.

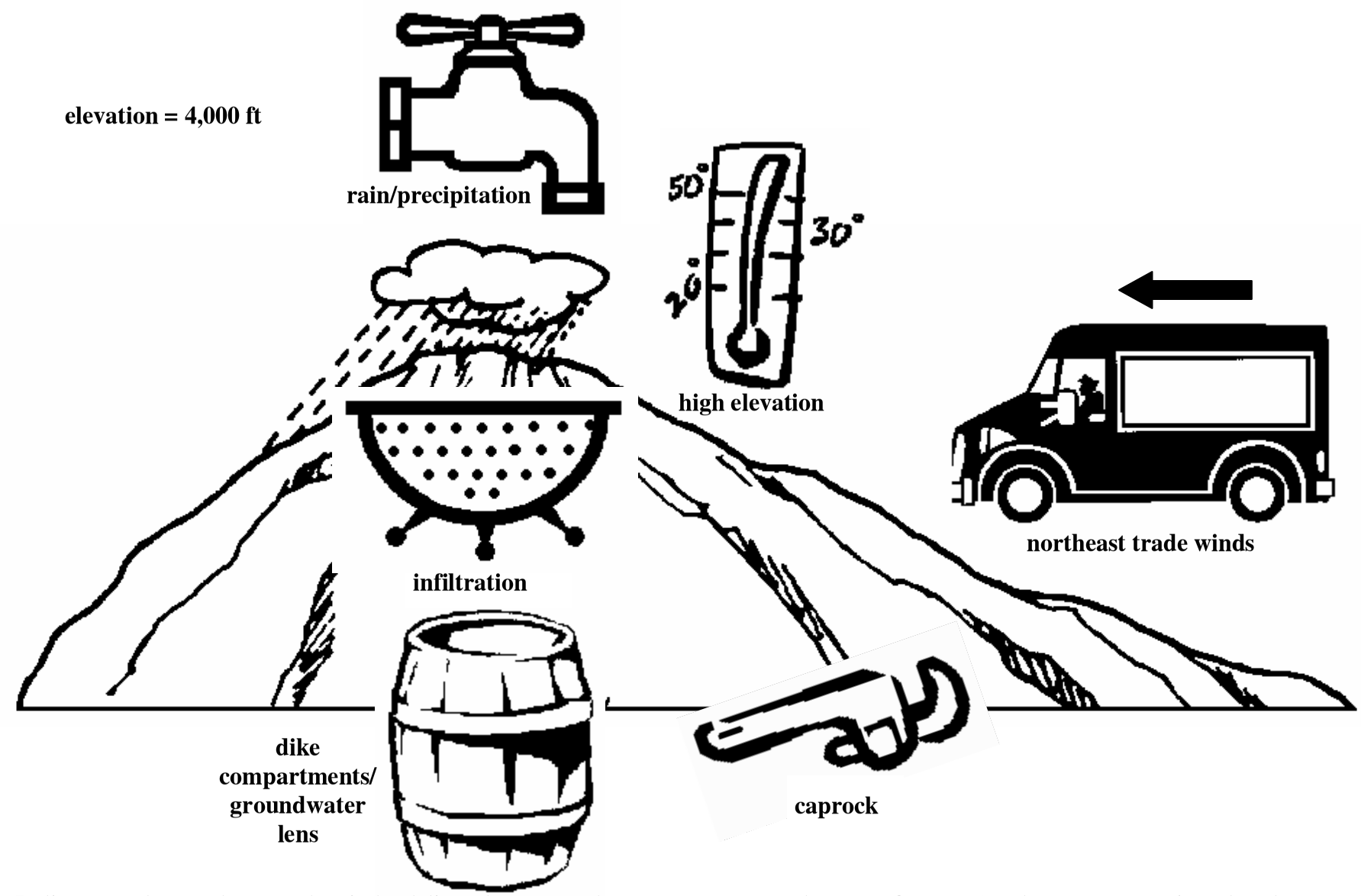












Delivery trucks (northeast trade winds) deliver the raw product, water vapor, to the water factory. An elevator (mountain) takes the water vapor up to the cooling system (high elevation). Faucets (rain clouds) produce water that passes through the colander's filtration system (lava rocks). The water is stored in barrels (dike compartments and the groundwater lens) in the water factory. A wrench (caprock) is used to prevent leaks out of the storage system.

Name: _____ Date: _____

Evaporation

Procedure: Place one pie tin indoors and one outside. Place a stone in the pie tin outside to weigh it down. Pour one spoonful of water in each pie tin. Record the time each experiment is begun. Observe how long it takes for the pans to dry out.

Questions: Which pan will dry first?

Hypothesis: _____

	Time, beginning	Time, ending	Amount of time to dry (minutes)
Pan, indoors			
Pan, outdoors			

Results: _____

Conclusion: _____

Is this an endothermic or exothermic reaction? Why? _____

Name: _____ Date: _____

Evaporation

Procedure: Wet the three strips of colored construction paper under a faucet and allow them to drain. Tape one strip indoors in a still, sheltered place. Tape another indoors in front of a fan or window, and the last outside in the sun. Observe how long it takes for each strip of paper to dry out. Record the time each experiment has begun and ended.

Question: Which strip will dry first?

Hypothesis: _____

_____

_____

	Beginning Time	Ending Time	Amount of time to dry (minutes)
Strip, sheltered area			
Strip, fan or window			
Strip, sun			

Observations: _____

_____

_____

_____

Conclusion: _____

_____

Is this an endothermic or exothermic reaction and why? _____

_____

Name: _____ Date: _____

Transpiration

Procedure: Select an outdoor plant with small, easy-to-reach leaves that are exposed to bright sunlight. Carefully break off a few leaves and place them in a zipper plastic bag. Leave the bag out in the sun near the plant. Next, place another bag over a few leaves still attached to the plant and zipper it closed. After half an hour check the bags.

Question: Which bag will have the most water?

Hypothesis: _____

Results: _____

Conclusion: _____

Is this an endothermic or exothermic reaction and why? _____

Name: _____ Date: _____

Infiltration

Question: Of three different ground areas (grassy, bare and compacted soil, or bare and loose soil), which will have the quickest water infiltration?

Hypothesis: _____

_____

_____

Procedure: Push one can into a grassy area not frequently walked on, another into bare, compacted soil and another over bare, loose soil beneath a bush. Pour a cup of water into each. Firmly hold each can to the ground so that water does not leak out. Time how long it takes for the water to infiltrate the soil. If possible, repeat over similar areas on slopes.

Location of can	Length of time of infiltration (minutes)
Grassy area	
Bare, compacted soil	
Bare loose soil under a bush	

Results: _____

_____

_____

_____

Conclusion: _____

_____

_____

_____

Name: _____ Date: _____

Condensation

Question: What do you think will happen with a cup of ice and cold water in the sun?

Hypothesis: _____

_____

_____

Procedure: Fill a tall clear glass cup with ice and cold water. Mark off the water level. Place in a warm area or outside in the sun for quick, maximum results. Observe.

Results: _____

_____

_____

_____

_____

Conclusion: _____

_____

Is this an exothermic or endothermic reaction and why? _____

_____

If you leave the glass where it is overnight, what will happen to the water level the next day? Try this and find out.

Hypothesis: _____

Next day result: _____

Conclusion: _____

_____