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Science Standard
5.3.c.

Student Workbook

California Education and the Environment Initiative

Precipitation, People, and the Natural World

California Education and the Environment Initiative

Approved by the California State Board of Education, 2010

The Education and the Environment Curriculum is a cooperative endeavor of the following entities:

California Environmental Protection Agency

California Natural Resources Agency

Office of the Secretary of Education

California State Board of Education

California Department of Education

California Integrated Waste Management Board

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Key Partners:

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Contents

The Sierra Snowpack

California's sunny beaches draw people to the state. The warm weather attracts visitors and people who move here. Many cities have grown near the warm coast. However, one of the state's most important natural resources is far from the coast where it is cold—the snow.

The snow high in the Sierra Nevada Mountains is California's largest source of fresh water. It supplies almost two-thirds of the water needed for California's people, crops, and livestock.

Like the beaches, the snowy mountains draw visitors. The Lake Tahoe area has about a dozen ski resorts. There are another dozen to the south. Have you heard of Squaw Valley, Alpine Meadows, Mammoth, or Snow Summit? Millions of people enjoy the mountains each year. The visitors ski. They see beauty in trees like the giant sequoia. They discover the interesting animals that live in the forest habitats on mountains.

Sierra Nevada, California

These snowy peaks are important for a more basic reason, however. When the snow melts, it runs off the land into rivers. The water flows into reservoirs made by building dams on the rivers. The water in the reservoirs is collected and stored for future use. Some of the water goes into underground aquifers. The water in both places is used as drinking water. People on farms use the water to grow crops. Water that collects behind dams is also used to make electricity.

Solid Storage

The water that comes from snow supplies life in California. As the number

of people in California grows, so does the need for water. Farmers need water to irrigate crops in the Central Valley. People in cities need water to drink and wash. The snow from the mountains provides water to meet the growing demand. We use water from the melting snow to meet these needs.

Over many years, the state government built several large water projects. The projects send river water into reservoirs, lakes built by people. Dams hold water in the reservoirs. Canals carry it to other parts of California. This has reduced the risk of water shortages when rainfall is low. The water projects also help control water from the mountains and stop flooding during heavy rains.

The amount of snow on the ground is called snowpack. Water managers measure it all year long. That way they know how much water is stored in the mountains. Because of the Sierra snowpack, our cities and farms have water when they need it. Managing this water supply is a huge job.

California began tracking this water supply more than 100 years ago. In fact, a professor took the first readings in 1905. In 1930, the state began doing snow surveys. Scientists measure the snow throughout the year. They take measurements at 265 places high in mountains. Skiers ski to these stations, carrying long poles and scales. They use the poles to measure the snow depth. In some years, the snow is more than 35 feet deep in some places. That is as tall as three and a half stacked school buses!

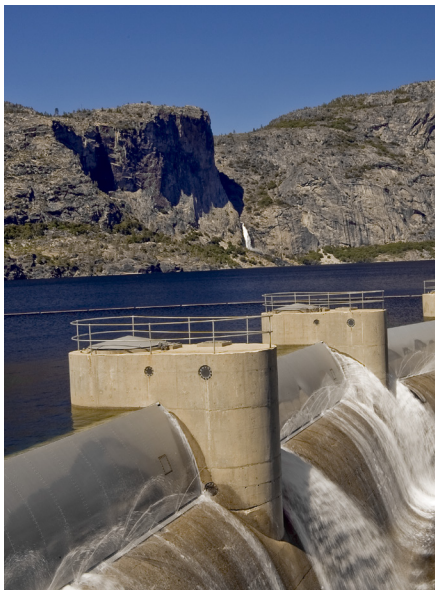
The scientists also weigh the snow. This lets them figure out the water density, or how much liquid water is contained in the snow. A dense or heavy snowpack means there is a lot of water. The scientists also use sensors for other kinds of measurements.

The measurements help scientists predict the water supply for the coming year. The April survey is the most important. This is the last reading of the winter. It is taken when the snowpack is at its peak. Scientists can then forecast how much water there will be when the snow melts. They use this information to make drought and flood warnings.

Climate Change

Greenhouse gases, such as carbon dioxide, affect Earth's climate by trapping heat and holding it in a kind of warm-air blanket that surrounds the planet. This process is called the greenhouse effect. Scientists estimate that the average temperature on Earth would be colder by approximately 54° F (30° C) without the greenhouse effect—too cold to sustain present-day ecosystems.

The greenhouse effect is essential to life on Earth. However, human activities, such as burning fossil fuels, have accelerated the natural process by producing more greenhouse gases.



Yosemite Dam, California

Earth's temperature is rising as a result of increased greenhouse gases. Rising temperatures have lead to the snowpack, in certain areas, melting earlier than it has in recent history. Scientists look at how much or little snowpack there is to help study the effects of climate change. People and other animals breathe out carbon dioxide. Plants use this gas to turn sunlight into food energy. This natural cycle means some of this gas is in the air all the time. Yet, the natural cycle is changing.

When energy or heat from the Sun enters the atmosphere, some of it hits Earth. Some of the Sun's energy then bounces back into space. Greenhouse gases capture heat which helps keep our planet warm enough for life on Earth. Plants use up a lot of the carbon dioxide. However, some human activities produce additional carbon dioxide, which is also released into the atmosphere.

The burning of fossil fuels, such as coal and oil, releases greenhouse gases. Driving cars and trucks and flying airplanes are examples of human activities that burn fossil fuels. The plants on Earth cannot use all this extra gas. Some of the carbon dioxide stays in the atmosphere. This means more heat from the Sun is trapped. This causes temperatures to rise, which heats up Earth's surface and water temperatures. This rise in temperature is called climate change. Climate change can produce hotter, drier conditions which can lead to more forest fires, more severe weather patterns, and melting of the global ice pack, which will lead to a rise in the sea level.

Ripple Effects

Warmer air causes snow to melt, or not to fall at all. This affects animals and plants that need snow to survive. During warmer times, some animals may need to move from their natural habitats. These animals must find higher, colder places on the mountains. Some of them may not be able to find new places to live.

The pika is one example. It is a small animal related to rabbits. They live in cold, alpine areas on mountains. They cannot survive more than six hours in warm weather. So, they cannot run across a warm area to get to another mountain. If their habitat warms up too much, they must climb to higher ground where it is colder. If they cannot find a cool enough habitat, they will not survive.

Another animal that lives in our snowy mountains is the Clark's nutcracker. This bird collects pine seeds. It buries them in the snow. The bird has an excellent memory. It can find seeds in thousands of hiding places. Living in cold, snowy habitats means the bird has little competition for seeds. This will change if warmer weather brings less snow. Other birds and animals adapted to a warmer climate might move in and take the seeds.

When there is less snow in the mountains, or snow melts too quickly, it causes trouble for people, too. Shorter ski seasons mean less people spending money to support businesses and mountain communities. Rapid melting of snow can cause flooding. California's hot, dry summers can cause water shortages and wildfires. Farmers have trouble growing crops with less water. This means higher prices for food. The water you use at home may cost more, too.

Pika

Water Supply

When climates change, it affects the water cycle, including the water supply. This is very important since the survival of people, animals, and plants depends on water.

The availability of water changes from year to year. For example, in 2006 there were heavy rains and runoff. Reservoir levels were higher than normal. Precipitation in 2007 was much lower. Snowpack measurements made in May showed that there was less water than normal. In Southern California, 2007 was the driest year on record. Runoff in major rivers was only about half of what was expected. State scientists knew that the extra water from 2006 would help with the 2007 shortages. In the spring of 2008, California's governor declared a drought in the state. Droughts occur slowly with the impacts increasing over time as supplies in reservoirs are depleted and groundwater levels decline.

State officials carefully manage the water supply. This careful water management helps meet the people's water needs. Their work, in addition to providing water for our daily needs, helps us prepare for droughts and flooding.

In dry places like most of California, each drop of water is precious. An extended period of below- average precipitation of water resulting in a reduction of water in available storage can result in a cutback in water service to customers.

Name: _____

Instructions: Below are definitions of different kinds of precipitation. Write the proper term to match each definition. (1 point each)

_____ 1. Precipitation in the form of drops of water

_____ 2. Rain that freezes when it hits the ground

_____ 3. Precipitation in the form of flakes of ice crystals

_____ 4. Precipitation in the form of frozen raindrops

_____ 5. Precipitation in the form of solid ice, that ranges in size from a pea to a softball, that occurs during intense thunderstorms

Instructions: Answer each of the following questions in a sentence or two in the space provided.

6. Provide three examples of how humans and human communities depend on precipitation. (3 points)

7. What role do state water projects play in providing water to people? (2 points)

8. How might changes in climate and precipitation affect animals? (2 points)

Name: _____

9. When and where do different forms of precipitation occur in California? (1 point each)

Rain:

Snow, sleet, and freezing rain:

Hail:

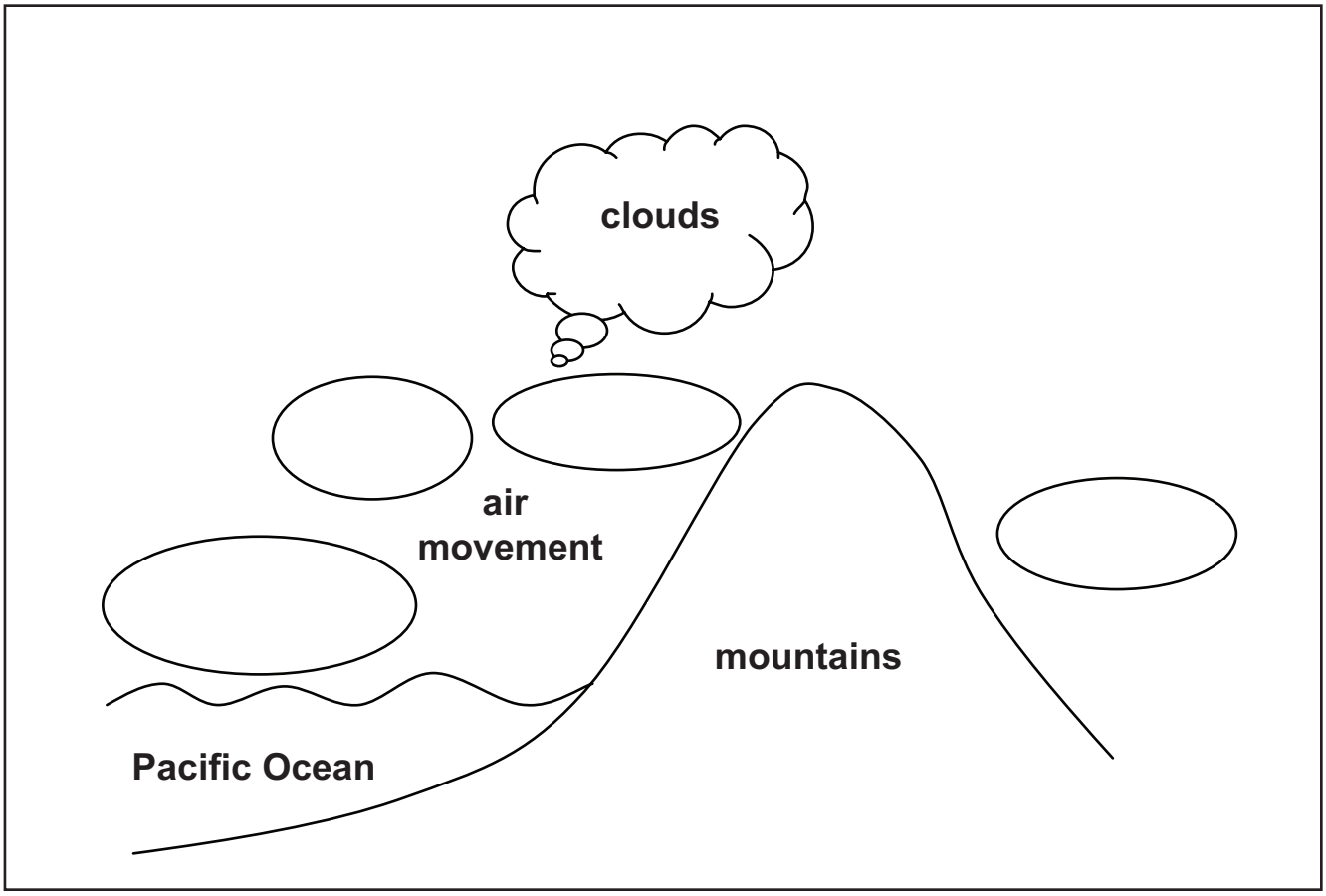
10. Give at least four reasons the Sierra Nevada snowpack is important to Californians. (4 points)

Name: _____

Instructions: Read Question 1 and complete the tasks on the illustration below.

1. The diagram shows a mountain on the coast of California. Draw an arrow to show how the air moves. Add labels to the diagram to show where you would find each of these conditions: (1 point each)

cooler air | precipitation | rainshadow | warm, moist air



Instructions: Answer each of the following questions in one to three sentences in the spaces provided.

2. What three things are needed for clouds to form? (3 points)

Name: _____

3. Describe how most clouds form in California. (3 points)

4. Why is fog so common on the California coast? (2 points)

Name: _____

Instructions: Use the **Natural Regions** and **Precipitation in California** student maps to answer the following questions in the spaces provided.

1. What areas of the state get the least precipitation? What natural regions exist in these areas? (2 points)

2. What are some of the plants that exist in these areas? (3 points)

3. What areas of the state get the most precipitation? (2 points)

4. How much precipitation is there in the southern Central Valley grasslands? (2 points)

5. Which gets more precipitation, the Central Valley grasslands or the oak woodlands? (1 point)

6. Which gets more precipitation, the Central Valley grasslands or the Mojave Desert? (1 point)

Name: _____

7. Which needs more water, oaks or grasses? (1 point)

_____

Grasses or creosote bushes? (1 point)

_____

8. What kind of vegetation is found in the part of California that gets the most rainfall? (1 point)

Do these plants grow in areas of low rainfall? (1 point)

_____

9. How are the **Precipitation in California** and **Natural Regions** maps similar? (1 point)

10. What do these maps tell you about the relationship between precipitation and natural regions? (2 points)

Name: _____

Instructions: Use the information provided on this page to color the correct counties on **Map of California Counties** on page 13.

- California is the largest agricultural state in the nation. Agriculture generates more than $31.8 billion per year.
- Farmers in California can grow many crops year-round because of the mild climate, fertile soil, and water.
- California grows more than half of the nation's fruits, vegetables, and nuts.

The top ten agricultural products in California are:

1) milk	2) grapes	3) nursery products	4) almonds	5) cattle
6) lettuce	7) strawberries	8) tomatoes	9) hay	10) flowers

To Do:
The chart below lists the top agricultural counties in the state. Find these counties on the map of California on page 2. Color them in. (2 points)

County	Farm Revenues	Farm Products
Fresno	$3.3 billion	grapes, poultry, cotton, tomatoes, milk
Tulare	$2.9 billion	milk, oranges, grapes, cattle, hay
Monterey	$2.3 billion	lettuce, broccoli, strawberries, grapes
Kern	$2.1 billion	grapes, citrus, almonds, cotton, milk
Merced	$1.4 billion	milk, chickens, almonds, tomatoes, alfalfa
San Joaquin	$1.3 billion	grapes, milk, tomatoes, almonds, asparagus
Stanislaus	$1.3 billion	milk, almonds, chickens, eggs, cattle
Riverside	$1.2 billion	milk, grapes, nursery, eggs, dates
San Diego	$1.2 billion	indoor plants, nursery stock, avocados, eggs
Imperial	$1 billion	cattle, alfalfa, lettuce, carrots
Ventura	$1 billion	lemons, strawberries, nursery stock, celery
Kings	$.8 billion	milk, cotton, cattle, turkeys, alfalfa hay
San Bernardino	$.7 billion	milk, cattle, eggs, nursery products, alfalfa

Name: _____

Instructions: Use the information provided on page 12 to identify and color the correct agricultural counties in California.

Map of California Counties

Name: _____

Instructions: Compare the **Map of California Counties** to the **Average Annual Precipitation in California** map. Then, using the map and the information below, answer the following questions in the spaces provided.

Water Makes Agriculture in California Possible

Crops are grown year-round in California. Most precipitation in California falls between December and May. Most of it falls in the mountains and on the northern coast. Snowpack in the mountains serves as a natural reservoir. As the snowpack melts, water flows into streams and rivers and some of it is captured in reservoirs. California water projects—dams, reservoirs, and aqueducts—move the water to farms.

Of the 202.5 million acre-feet of precipitation that falls in California annually, 34 million acre-feet, about 17%, are used for agriculture. California's farmers use water to irrigate approximately 10 million acres of crops each year. (One acre-foot equals 326,000 gallons, enough to almost cover a football field with a one-foot depth of water.)

1. Farming in Riverside, San Diego, and Imperial counties takes place at lower altitudes. How much precipitation falls in these lower altitude areas each year? (2 points)

   _____

2. Where are San Joaquin, Merced, Stanislaus, and Kern counties located? How much precipitation do these counties receive each year? (2 points each answer)

   _____

3. Vegetable crops need an average of two inches of water per week. How many inches of water is that per year? (2 points)

   _____

4. From where does the water needed to grow crops come? (2 points)

   _____

Name: _____

Instructions: Read the following paragraph and complete the tasks in the space provided. Draw a diagram that shows how people all over California use water that falls as precipitation in the Sierra Nevada. Show ways in which Sierra Nevada water is used throughout the state. Explain how water gets from the mountains to where people need it. Include pictures, words, and symbols. (10 points)

Name: _____

Instructions: Read the information below, follow the instructions, and record your observations in the chart below.

Experiment:
What you need: water, white vinegar, five paper cups, quarter-cup measure, chalk, water plants, waterproof pen, three pieces of a water plant

Some things you need to know:

- Bottled water is not acidic.
- Vinegar is an acidic liquid.
- The plant you are using is a plant that lives in water.

What to do:

Part 1: The Effect of Vinegar and Water on Chalk

Instructions: Before you do the experiment, observe the chalk. Describe it in the "Before" column below. Consider different ways to describe it. For example, observe its color, hardness, or size. After the experiment, what do you notice? Has anything changed? Describe each piece of chalk in the "After" column below. (1 point per box)

	Observations of Chalk – Before	Observations of Chalk – After
Water		
Vinegar		

1. Label one cup "water." Pour some water in the cup so the water is about one inch deep.
2. Label the other cup "vinegar." Pour some vinegar in the cup so the vinegar is about one inch deep.
3. Put one piece of chalk in the vinegar and one piece of chalk in the water.
4. Watch what happens to the chalk in each cup. Record your observations.

Name: _____

Part 2: The Effect of Acid Water on Water Plants

Instructions: Before you do the experiment, observe the plants. Describe them in the "Before" column below. Consider different ways to describe them. For example, you observe their color, how they feel, or their size. After the experiment, what do you notice? Has anything changed? Describe each plant in the "After" column below. (1 point per box)

	Observations of Plants – Before	Observations of Plants – After
100% water		
50% vinegar and 50% water		
100% vinegar		

1. Use the quarter-cup measure to measure out the amount of vinegar and water you need. Use one-quarter cup vinegar and one-quarter cup water to make a 50% vinegar solution. Set up and label three cups as follows:
   - 100% water
   - 50% vinegar and 50% water
   - 100% vinegar

2. Add one water plant, in same-size pieces, to each of the cups. Let the cups sit overnight.

3. Observe any changes in the plants in each cup.

Name: _____

Instructions: Read each question and answer the questions in complete sentences in the spaces provided. (3 points each)

1. How did the chalk in each of the cups change?

2. Chalk is made of calcium carbonate. Limestone and marble are also made of calcium carbonate. Some acid rain is as acidic as vinegar. How might buildings and statues made of limestone or marble change over the years if exposed to acid rain? Explain.

3. How did the water plants in each of the cups change?

4. Some lakes in the eastern United States are almost as acidic as vinegar. What might be happening to the plants and animals in these lakes?

Name: _____

Acid Rain—Past, Present, and Future

The steam engine was invented in the late 1700s. Factories powered by steam engines were built all over England. These new engines burned coal. When coal burns, it creates smoke. This smoke started filling the air.

In 1872, a Scottish scientist named Robert Smith studied London's air and rain. He found that the acid in rain was increasing. He was the first to connect burning coal to this change. Smith knew the smoke was filled with chemicals.

Ninety years later, another scientist did a similar study. Svante Oden studied rain in Sweden. In 1962, he discovered that their acid rain came from polluted clouds. These clouds were drifting in from other parts of Europe.

Scientists began measuring the acid in rain in the United States during the 1960s. At that time, only New York and Pennsylvania had acid rain. The type of coal burned in these two states was different from coal burned elsewhere. The coal they burned created more of the chemicals that cause acid rain. By 1980, scientists were finding acid rain in most of the states east of the Mississippi River. Coal-burning power plants that produce electricity were causing most of the acid rain in the eastern states.

The rain put acid in the soil, too. In response, people passed laws to clean up the smoke from factories. Factories, power plants, and cars were changed. They still pollute the air, and acid rain and soil still exist, but today's factories and cars produce less of the materials that cause acid rain.

The damaging rain continues to be a problem in the eastern United States. Fish cannot live in lakes filled with acid. Trees may not survive in acidic soil and could die from acid rain. This rain can also wear away at buildings, statues, and other human-made structures.

Western states do not burn much coal to produce electricity. Therefore, the problem is not as severe as it is in the East. However, exhaust from cars and trucks also causes acid rain. So the rain and fog in places that have more cars, have more acid. That includes Los Angeles and other dense urban areas.

Today, the country that faces the greatest challenge from acid rain is China. It uses more coal than the United States, Europe, and Japan combined. China is building many new factories. Almost every week another coal-fired power plant opens somewhere in the country. Each new power plant is big enough to serve all the homes in San Diego.

Name: _____

Instructions: Read the tasks and respond to them in the spaces provided.

1. Write one question about acid precipitation to ask the other students in your group. Base your question on this reading, or any other information from this lesson.

2. In your groups, take turns asking your questions. Discuss the answers. Record each question here. Write your answer to each question in the spaces provided. (16 points: 2 points for each question and 2 points for each answer)

My question:

Answer:

Question from a group member:

Answer:

Name: _____

Question from a group member:

Answer:

Question from a group member:

Answer:

Name: _____

Instructions: Answer each question with a complete sentence in the spaces provided. (2 points each)

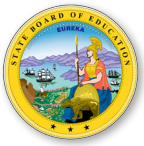
1. Explain why warm air rises over urban heat islands.

2. Why are rainstorms more common around urban heat islands in the southeastern United States?

3. Scientists discovered that precipitation downwind of cities in Texas was greater than average during 1999–2003. What could explain the increase?

4. Scientists found that precipitation has decreased downwind of cities on the coast of California. What could explain this decrease in precipitation?

5. Why are precipitation patterns changing in the Sierra Nevada? How are they changing?



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