Unleash the Power of the Sun...Featuring Sunny H2O

Summary

Students will understand that the sun is the main source of heat and light for things on Earth. With this knowledge, students will investigate the state of water as it moves through the water cycle.

Additional Core Ties

English Language Arts Grade 3
Writing Standard 2
English Language Arts Grade 4
Writing Standard 2
Mathematics Grade 3
Strand: MEASUREMENT AND DATA (3.MD) Standard 3.MD.3
Mathematics Grade 3
Strand: MEASUREMENT AND DATA (3.MD) Standard 3.MD.4
Mathematics Grade 4
Strand: MEASUREMENT AND DATA (4.MD) Standard 4.MD.1

Time Frame

3 class periods of 30 minutes each

Group Size

Small Groups

Life Skills

Thinking & Reasoning, Communication

Materials

- 15 thermometers (laser or red filled)
- Two 500 mL wide mouth graduated glass beaker
- Two 50 mL wide mouth graduated glass beaker (to fit in the 500 mL)
- 1 large roll Saran wrap
- Small pebbles
- Ice cubes (optional)
- Dirt
- 1 roll of duct tape
- 1 250 Watt clamp lamp (optional)
- 1 Infrared blub (optional)
- 1cd with music
- 1 cd player (for kinesthetic dance)

Background for Teachers

Misconceptions to address:

- The water cycle does not have a beginning or an end. It can start anywhere in the cycle and end anywhere in the cycle.
- Sun has both HEAT and LIGHT (other examples of things that give off heat and light: light bulbs, fireflies).

Identify what type of heat source is being used: MECHANICAL or ELECTRICAL.

Background Information:

See websites.

Be sure to note that evaporation and condensation are opposite of each other.

If the experiment does not work - that's okay! There are not always perfect results in science.

Vocabulary

- Temperature:
  How warm or cold an object is
- Degrees:
  Unit used to measure temperature displayed on a thermometer
- Heat source:
  It makes things warmer
- Misconception:
  A misunderstanding of an idea
- Vapor:
  The state of water where it is a gas and cannot be seen
- Precipitation:
  When water falls to Earth in the form of rain, snow, sleet, or hail
- Evaporation:
  When small parts of water are heated enough to change from the liquid state to gas state
- Condensation:
  When the small parts of water in the state of a gas collect together and become a liquid. This is usually caused by water vapor losing heat energy.
- Water cycle:
  The way water changes as it moves from the surface of the Earth, through the air and returns again through the different processes. The sun causes this to happen.
- Mechanical heat source:
  something that does not use electricity ex: pencil sharpener
- Electrical heat source:
  something that uses electricity ex: light plugged into wall

Student Prior Knowledge

How to read volume (ml), temperature (F)

Be familiar with the word molecule (more than one atom combined - the small "parts" of water)

Timeframe:

Part 1: Temperature Investigation, 20 minutes

Part 2: Water Cycle Investigation 30 minute initial observation, 5 minutes a day for ongoing observation for approximately 10 days, 30 minute conclusion

Part 3: Water State Dance, 20 minutes

Intended Learning Outcomes

1. Use Science Process and Thinking Skills

a. Observe simple objects and patterns and report their observations.

e. Use instruments to measure length, temperature, volume, and weight using appropriate units.

f. Conduct a simple investigation when given directions.

2. Manifest Scientific Attitudes and Interests

a. Demonstrate a sense of curiosity about nature.

c. Pose questions about objects, events, and processes.
3. Understand Science Concepts and Principles
a. Know science information specified for their grade level.
c. Explain science concepts and principles using their own words and explanations.
4. Communicate Effectively Using Science Language and Reasoning
a. Record data accurately when given the appropriate form and format (e.g., table, graph, chart).
b. Report observation with pictures, sentences, and models.
c. Use scientific language appropriate to grade level in oral and written communication.

Instructional Procedures

Part 1: Temperature Investigation
Time: 20 minutes
Goal: Students will understand that the sun is the main source of heat for things living on Earth.

Begin with a class discussion about sun and shade using the following questions:

Who has stood outside in the sun? How did the temperature feel to you in the sun? Was it bright or dark? In the sun, it is warm and bright.

Who has stood outside in the shade? How did the temperature feel to you in the shade? Was it bright or dark? In the shade, the temperature is cooler than in the sun and it is darker than in the sun.

Explain to students that they will go outside in small groups to collect temperature data in degrees Fahrenheit for areas in the sun and shade (if using red filled thermometers) or temperature data in degrees Fahrenheit of objects in the sun and shade (if using laser thermometers). Each group should collect data from different areas or objects, but all groups should collect data from one area or object in the sun and one area or object in the shade.

Ask the class to think about their experiences in the sun and shade. Ask them if they think that the temperatures they take in the sun and the shade will be the same or different? Will temperatures in the sun be greater or less than temperatures in the shade? As a class create a hypothesis, a testable statement that can be proven untrue. For example, "The temperatures in the sun will be greater than the temperatures in the shade." It is okay if students create a hypothesis that you know is incorrect. The important science concept is that a hypothesis is based on observation and prior knowledge, a hypothesis can be tested, and it can be support or proven wrong with evidence from investigations/experiments.

Send small groups of students outside to collect the following information for two areas or objects:

Area or Object?	Sun or Shade?	Temperature in Degrees Fahrenheit?

When students return inside, ask them to record their data on two class charts:

Chart 1: Temperatures in the Sun

Scientists?	Area or Object?	Temperature in Degrees Fahrenheit?
One row for each group		

Chart 2: Temperatures in the Shade

Scientists?	Area or Object?	Temperature in Degrees Fahrenheit?
One row for each group		

When all the data has been recorded guide a class discussion about the data using the following questions:

Were the temperatures your group observed and recorded in the sun and shade the same or different? The temperatures in the sun and shade were different.

How were the temperatures in the sun and shade different? The temperatures in the sun were higher than the temperatures in the shade.

Look at the class charts. What pattern do you observe in the data? Temperatures taken in the sun have higher temperatures than the temperatures take in the shade.

What could explain this pattern? The sun provides heat to Earth.

Why do you think this pattern was observed? The heat from the sun is blocked by an object in the shade. In the sun, no heat is blocked.

Did the data support our class hypothesis? Answers will vary based on class hypothesis.

So based on this investigation, what is the main source of heat for Earth? The sun.

Would you change anything in the process if you did this investigation again? For example, students may want to measure the temperature of more areas or objects, measure temperature over a period of days, or measure temperatures indoors.

Part 2: Water Cycle in a Beaker

Time: Initial Observation, 30 minutes Daily Observations, 5 minutes per day Concluding Discussion, 30 minutes

Goal: Students will understand that water changes state as it moves through the water cycle.

Discuss with students about how they could solve a scientific question. They could look up information in the library or on the Internet, ask an expert, or do an experiment.

Explain that scientists follow a process that is used to systematically gather information about Earth and they will be using this same scientific process to gather information about water. If necessary, watch the following video to familiarize students with the scientific process: http://www.youtube.com/watch?v=MV8lSmIo4Ac

Assemble two, Water Cycle in a Beaker (WCB).

Place a piece of duct tape on the bottom of a 50 mL graduated beaker.

Tape the 50 mL beaker inside the middle of a 500 mL graduated beaker.

If using a red filled thermometer, tape it so that the bottom of the red filled thermometer is at the 300 mL mark of the 500 mL graduated beaker. Be sure that you can read it without removing it.

Fill the 500 mL graduated beaker with 100 mL of water. Be sure that no water is in the 50 mL graduated beaker.

Allow each student to mix something "yucky" into the water, such as dirt, bubble gum, or leaves. Be sure that nothing "yucky" is in the 50 mL graduated beaker.

Place the Saran wrap tightly over the mouth of the 500 mL graduated beaker.

Place pebbles in the middle on the Saran wrap so that there is a low point in the Saran wrap directly over the 50 mL beaker.

Tape the Saran wrap in place so that it is air tight.

Place one of the WCB in a sunny area, like a window. Place the second WCB in a shady area, such as a closet or under a desk.

In small groups, ask students to record the following information:

Who are the scientists in your group?

What do you initially observe about both WCBs? What is the same? What is different? Descriptions should include that each WCB is set up the same with "yucky" water in the large beaker and no water in the small beaker, but one is in a sunny area and one is in a shady area.

How does heat from the sun affect temperature? It causes the temperature to increase.

How is water affected by heat from the sun? Think about what happens to a small puddle on a sunny day. Heat from the sun makes the puddle disappear.

Finish the following sentence. I think that the heat from the sun will cause the water in the large beaker will…turn blue (for example). This statement does not have to be correct because it is a hypothesis.

What is the temperature of the WCB in the sunny area? What is the temperature of the WCB in the shady area?

Each day, allow one student to observe the WCB in the sunny area and one student to observe the WCB in the shady area until all students have made at least one observation.

Students should record the following information in a Google Doc or spread sheet for each WCB:

Scientist?	Time in Days?	Temperature in Degrees Fahrenheit?	Estimated amount of water in the small beaker in mL?	Estimated amount of water in the large beaker in mL?	Additional Observations?
					These may include the presence of water droplets on the Saran wrap, the water in the small beaker is clean, the weather, time of day, etc.

Once all students have made observations, explain to students that over the last couple weeks they have made observations, collected data, and recorded data. These actions are part of the process that scientists use to answer questions.

Explain to students that once data is collected, scientists analyze the data, draw conclusions, or make inferences based on the data. Explain that they will analyze their classroom data in their original small groups.

Give each group a copy of the data the class collected for the WCB in the sunny area and the WCB in the shady area. Depending on students' abilities, you may want to ask the students to analyze the data (such as graphing, looking for patterns, comparing WCB in a sunny area to a WCB in a shady area, etc.) and see what they come up with. Or you can provide students with more structure using the following questions:

How could we graph the data?

Temperature vs. Time in Days

Amount of water in small beaker vs. Time in Days

Amount of water in large beaker vs. Time in Days

What patterns do you observe in the graphs? Temperature in the WCB in a sunny area changed more than the temperature in a shady area, the amount of water in the small beaker increased, the amount of water in the large beaker decreased, etc.

Do you observe any other patterns in the data? As the temperature increased in the WCB, water droplets appeared on the Saran wrap.

What could explain the observed patterns? Heat energy from the sun caused the water cycle to occur in the WCB.

Why do you think these patterns were observed? The water cycle is occurring in the WCB faster in the sunny area than in the shady area.

As a class, explain that the WCB is a small model for a cycle that occurs on Earth, called the

water cycle. Watch Ecogeeks Water Cycle Podcast.

Ask each student to identify how the water cycle relates to the WCB by diagraming a picture of the water cycle inside the WCB in a sunny area. Each diagram should contain the following:

a. Sun:
   The main source of heat energy for the water cycle is the sun. The sun is the main source of heat energy for the WCB in a sunny area.
b. Evaporation:
   Heat energy from the sun causes water to change from a liquid into a gas/vapor. This process is called evaporation. Water evaporates from the large beaker in the beginning of the investigation.
c. Condensation:
   When the vapor comes into contact with the Saran wrap, it loses heat and changes from water vapor back into liquid forming droplets on the Saran wrap. The process of changing from a vapor into a liquid is called condensation. It is the opposite of evaporation.
d. Precipitation:
   As the water droplets collect on the Saran wrap, their size increases causing them to fall off the Saran wrap into the small beaker because of the pebbles directing them there. The water droplets are a form of precipitation, called rain.

Following the discussion of how the water cycle relates to what was observed in the WCB in a sunny area and shady area, ask students to get back in their groups and answer the following questions:

What remained in the 500 mL graduated beaker at the end of the observation period? "Yucky" water.

What remained in the 50 mL graduated beaker at the end of the observation? Clean water.

If no water was placed in the small beaker in the beginning of the experiment, how did the water get in the small beaker? The "yucky" water evaporated from the large baker, condensed on the Saran wrap, and precipitated in the small beaker.

Is the water in the small beaker clean? Yes.

Why is the water in the small beaker clean? Usually only liquid evaporates. Water is a liquid, so it evaporated leaving behind all the "yucky" stuff in the water.

What similarities and differences do you observe in the WCB in a sunny area and shady area? Similarities may include that both WCB have "yucky" water, clean water, etc. Differences may include temperature readings, amounts of water in the large beaker and small beaker, etc.

What could explain the observed similarities and differences? The WCB in a sunny area received more heat energy from the sun, thus raising the temperature of the water causing the water cycle to occur more quickly in the WCB in a sunny area than the WCB in a shady area.

Did the data support your group hypothesis? Answers will vary based on group hypothesis.

Would you change anything in the process if you did this investigation again? Answers will vary based on group discussion.

What new questions do you have about water, heat energy from the sun, or temperature? Answers will vary based on group discussion.

Part 3: Water State Dance

Time: 20 minutes

Goal: Students will understand the relationship between heat energy from the sun and the states of water.

Illicit the three states of water from students by having students think of their experiences with water - ice skating, swimming, and cooking. Ice, like frozen water we put in our drinks or skate on in the winter, is water in a solid state. Water, like water that comes out of our faucets or we swim in, is water in a liquid state. Water vapor, like the feel of our breath when we exhale on our hands or feel above a pot of boiling water while cooking, is water in a gaseous state.

Explain to students that the water molecules move differently in each state of water. In a solid state water molecules move so little it seems they are standing still. Since the water molecules are not moving very much in a solid state, they can fit closely together. In a liquid state water molecules move around more over a slightly bigger area. Since the water molecules are slowly moving around in a liquid state, they spread out more. In a gaseous state water molecules move around the most and over a large area. Since the water molecules are quickly moving around the most in a gaseous state, they spread out over a large area.

Ask students to think about the temperature investigation from Part 1 and the water cycle investigation from Part 2. Remind them that the sun is the main source of heat for Earth and is the main energy source for the water cycle. Based on this knowledge, ask students to infer the cause of state changes of water. The heat from the sun is the main cause of state changes of water.

Explain to students that they are going to become water molecules (the smallest unit of water) and model how heat energy from the sun, represented by the classroom light, causes state changes in water. Very clear behavior expectations need to be established with students because there is a lot of movement and personal interaction in this activity. Guidelines might include only gentle bumps, fast walking feet, when the music stops all focus returns to the teacher, etc.

Students begin as water in its solid state, ice. As ice, students stand in place with their hands on their hips, closely together so that their elbows touch, and move very little. With the classroom light off, play the song, *Ice Ice Baby,* by Vanilla Ice. Hold up a sign that says *Solid* with a picture of ice on it as students model solid water.

Turn off the music.

Inform students that turning on the classroom light and playing the song *Sunshine on my Shoulders*, by John Denver, represents the addition of heat energy from the sun. Shining the light on students represents heat energy traveling from the sun to the water molecules (students), resulting in increased temperature and molecular movement leading to a state change.

Turn on the light and play *Sunshine on my Shoulders*. Students should begin to move slowly, over a larger area, gently bumping into each other.

Turn off the music and the light.

Tell students they are now a liquid. As a liquid, students should move around a little bit but stay close together. Play the song *Singing in the Rain*, by Gene Kelly. Hold up a sign that says *Liquid* with a picture of water on it as students model liquid water.

Turn off the music and light.

Add more heat by turning on the light and playing *Sunshine on my Shoulders*. Turn the liquid into a gas. In its gaseous state, water molecules move freely. This is the process of evaporation. Hold up the sign that says *Evaporation* with a picture of a pot of boiling water and an arrow pointing to the steam. Be sure to explain that we do not see evaporation happening, but the picture is a representation of evaporation.

Tell students they are now a gas or vapor. As a gas students should step away from each other and roam quickly and randomly around the room. Play the song *Rights of Spring*, by Igor Stravinsky. Hold up the sign that says *Vapor* with a picture of a pot of boiling water and an arrow pointing to the steam as students model water gas. Again, be sure to explain that we do

not see vapor, but the picture is a representation of vapor.
Turn off the music and the light.
Explain to students that eventually heat energy will be lost from the water molecules. The loss of heat energy is represented by a flash of the classroom light and playing the song *Cold as Ice* , by Foreigner. Turn on the music and flash the light. Instruct students to form small groups with students closest to themselves creating droplets of water throughout the room. This is the process of condensation. Hold up the sign that says *Condensation* with a picture of a cloud as students model condensation.
Turn off the music.
Play the song *Singing in the Rain* to signal to students that they have returned to a liquid state. The water droplets then precipitate to the ground by wiggling down to the floor. Hold up the signs that say *Liquid* and *Precipitation* with a picture of rain as students model liquid water and rain.
Turn off the music.
Play the song *Cold as Ice* and flash the light to signal to students that energy is still being lost.
Turn off the music.
Explain to students that they have lost all the energy that the sun originally gave them, so they are back to a solid state of water again, ice, and they should model this water state. Play the song *Ice Ice Baby*. Address the misconception that ice cubes do not give off cold. But rather, heat travels from the molecules/objects with the higher temperature, such as a hand, to the molecules/objects with the colder temperature, such as an ice cube. An ice cube is absorbing heat energy from a hand so it feels cold. Hold up the sign that says *Solid*.
Turn off the music.
Guide a class discussion about the relationships between the sun, heat, temperature, and water.

What is the heat source for Earth? The sun.
What is the main heat source for the water cycle? The sun.
How does the heat from the sun change water states? It causes solid ice to melt and liquid water to evaporate to water gas/vapor.
How does a loss of heat change water? It causes water gas/vapor to condense to liquid water and liquid water to solidify to ice.

Strategies for Diverse Learners

- Kinesthetic learners:
  dance, and data taking outside
- Visual Learners:
  draw a picture of the water cycle in Utah
- Auditory Learners:
  discuss verbally the water cycle as you compare data
- ELL:
  Printed words, visuals, diagrams, pictures, "Sentence Starters" (the patterns I observed with objects in the sun_____, when we started this activity, this is what I thought _____now that we have finished this is what I now know_____) to help in starting discussions that will be talked about as a class.

Extensions

Cloud in a jar experiment Web site

Temperature Extension: Compare temperatures of different colors in sunny areas to temperatures of different colors in shady areas.

Water Cycle Extension: Make a Could in a Jar Demonstration: http://eo.ucar.edu/webweather/cloudact1.html
Water Cycle Extension: Water Cycle Walk. Head outside and walk around your school grounds looking for evidence of the water cycle.
Water Cycle Extension: Watch a time lapse video of puddles evaporating.
States of Water Extension: Hex Bugs Demonstration: Use Hex Bugs to model water molecules during the different states of water.

Assessment Plan

Draw and explain how the water cycle takes the dirty water in the large beaker and produces clean water that fills the smaller beaker.
Finish the sentence frames. When we started the investigation, this is what I thought_____. Now that we have finished the investigation is what I now know_____.
Place students in small groups. Ask each group to think about the temperature investigation, the water cycle in a beaker investigation, and the water state dance. Ask student to discuss how the information learned relates to us in Utah. Using these ideas and information learned in these lessons, ask students to create a quick Utah water cycle dance, rap, play, or drawing incorporating the following words and concept into movement or lyrics: a. Water Cycle b. Heat Source c. Sun d. Temperature e. Degrees f. Evaporation g. Vapor h. Condensation i. Liquid j. Precipitation k. Water Changes State

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