AQUARIUS
Education & Public Outreach

The Water Cycle –
Now You See It, Now You Don't

Unit: *Salinity Patterns & the Water Cycle* **I Grade Level:** *Elementary* **I Time Required:** *Introduction - 30 min. - Activity as groups – 45min – Wrap Up – 20 min* **I Content Standard:** *NSES Physical Science, properties of objects and materials* **| Ocean Literacy Principle 1f:** *The ocean is an integral part of the water cycle and is connected to all of the earth's water reservoirs via evaporation and precipitation.*

Big Idea:
Water can change states among liquid, vapor (gas), and ice (solid) at various stages of the water cycle. Temperature affects the change of water from one state to another. When water vapor gets cold it changes to a liquid. This is called condensation. When heat is applied to water, it changes from a liquid to a gas. This is called evaporation. This activity will focus specifically on two aspects of the water cycle: evaporation and condensation.

Key Concepts:
- Evaporation occurs when a liquid is changed into a gas.
- Evaporation occurs when the temperature of a liquid is increased.
- Condensation occurs when a gas is changed into a liquid.
- Condensation occurs when the temperature of the vapor decreases.
- When the sun heats up water in rivers, lakes or the ocean, it turns into vapor or steam. The water vapor or steam leaves the body of water and goes into the air.

Essential Questions:
- How does water change?
- How does water move?
- How does life depend on water?
- Where does the water that forms on the outside of your drinking glass in the summer time come from?
- Where does the water go when it is evaporated?

Knowledge and Skills:
- Observe the relationship between temperature and condensation and temperature and evaporation.
- Water vapor in the air gets cold and changes back into liquid water.
- When water is heated it changes into a gas.
- Use a model to simulate the water cycle.

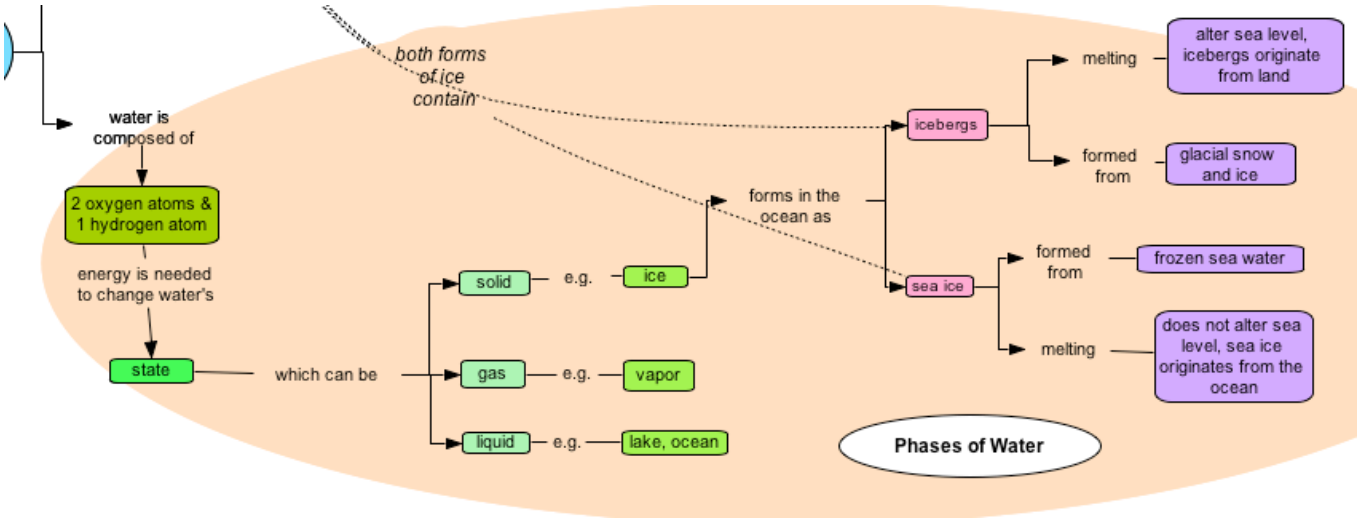
Prior Knowledge:
- Basic familiarity with the water cycle as a diagram and introduction to the terms used to describe the various stages water goes through in a cycle.
- Some events in nature have a repeating pattern—such as daily weather patterns or changes in temperature and the appearance of rain and snow at different times of the year.
- Water can be a liquid, solid, or gas and can go back and forth from one form to the other.
- Water left in an open container disappears, but water in a closed container does not disappear.

Common Preconceptions:
- The water in a drinking glass seeps through the wall of the glass, or evaporates from the inside and

condenses on the outside.

- Students have a difficult time accepting the idea of invisible particles of water in the air.
- Students understand the concept of boiling and freezing well before understanding evaporation and condensation.
- The water cycle involves freezing and melting of water.
- Condensation occurs because the “coldness changed into water,” or “cold caused oxygen and hydrogen to change to water.”
- When water evaporates, it just disappears and ceases to exist.
- When water evaporates, it immediately goes up to the clouds or into the sun.

Concept Map- A concept map can be a helpful evaluation tool for an activity such as this, see Assessment Activities for further ideas. The map provided here relates to the branch “Phases of Water” from the comprehensive Aquarius Concept Map – *Water & its patterns on Earth’s surface*.



Background

The water cycle has no starting point. But, we'll begin in the oceans, since that is where most of Earth's water exists. The sun, which drives the water cycle, heats water in the oceans. Some of it evaporates as vapor into the air. Ice and snow can sublimate directly into water vapor. Rising air currents take the vapor up into the atmosphere, along with water from evapotranspiration, which is water transpired from plants and evaporated from the soil. The vapor rises into the air where cooler temperatures cause it to condense into clouds. Air currents move clouds around the globe, cloud particles collide, grow, and fall out of the sky as precipitation. Some precipitation falls as snow and can accumulate as ice caps and glaciers, which can store frozen water for thousands of years. Snowpacks in warmer climates often thaw and melt when spring arrives, and the melted water flows overland as snowmelt. Most precipitation falls back into the oceans or onto land, where, due to gravity, the precipitation flows over the ground as surface runoff. A portion of runoff enters rivers in valleys in the landscape, with streamflow moving water towards the oceans. Runoff, and ground-water seepage, accumulate and are stored as freshwater in lakes. Not all runoff flows into rivers, though. Much of it soaks into the ground as infiltration.

Evaporation drives the water cycle. Evaporation from the oceans is the primary mechanism supporting the surface-to-atmosphere portion of the water cycle. After all, the large surface area of the oceans (over 70 percent of the Earth's surface is covered by the oceans) provides the opportunity for such large-scale evaporation to occur. On a global scale, the amount of water evaporating is about the same as the amount of water delivered to the Earth as precipitation. This does vary geographically, though. Evaporation is more prevalent over the oceans than precipitation, while over the land, precipitation routinely exceeds evaporation. Most of the water that evaporates from the oceans falls back into the oceans as precipitation. Only about 10 percent of the water evaporated from the oceans is transported

over land and falls as precipitation. Once evaporated, a water molecule spends about 10 days in the air. The process of evaporation is so great that without precipitation, runoff, and discharge from aquifers, oceans would become nearly empty over time.

Condensation is the process by which water vapor in the air is changed into liquid water. Condensation is crucial to the water cycle because it is responsible for the formation of clouds. These clouds may produce precipitation, which is the primary route for water to return to the Earth's surface within the water cycle. Condensation is the opposite of evaporation. You don't have to look at something as far away as a cloud to notice condensation, though. Condensation is responsible for ground-level fog, for your glasses fogging up when you go from outside on a cold winter day and to inside a warm room, for the water that drips off the outside of your glass of iced tea, and for the water on the inside of the windows in your home on a cold day.

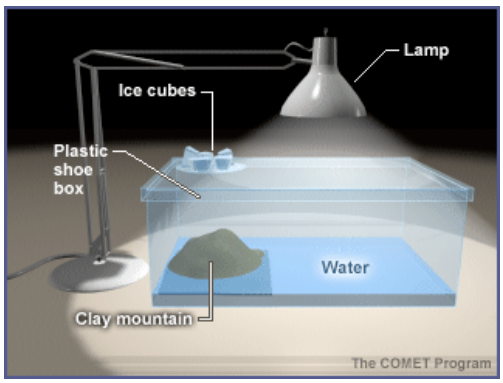
From US Geological Survey – The Water Cycle
https://www.usgs.gov/special-topic/water-science-school/science/a-comprehensive-study-natural-water-cycle

Materials:
Artists clay or plastic mountain model; plastic (transparent) shoebox with cover or a small glass aquarium and plastic wrap for a cover; Petri dish; lamp; water; ice, data sheet

Preparation:
If you have a large aquarium, you can do this activity as a demonstration, allowing the students to study and observe the phenomena and develop their own ideas and conclusions for class discussion. With sufficient materials, you can also do it as a group project, with teams of three to five students responsible for setting up the model and drawing conclusions from their own work. The activity is described below as if it were a demonstration. As always, it's important not to overly explain what is "supposed" to happen, but rather let them discover the model cycle for themselves.

Activity –

- Using a white or chalk board to record student thoughts and discussion points, engage the class in a discussion on the water cycle. Integrate the K-W-L strategy through the discussion - What I Know, What I Want to Know, and What I Learned. Revisit this discussion in the assessment piece.
- Using the clay, shape a mountain. Place the mountain on one side of the shoebox with the sloped side facing the interior of the box where the "ocean" will be.
- Pour water into the "ocean" basin until about one-fourth of the mountain slope is covered. Replace the lid of the shoebox.
- Place a petri dish on top of the shoe box over the mountain (as shown). Place crushed ice into the petri dish.
- Position the lamp over the ocean. Turn on the lamp. CAUTION: THE LAMP WILL GET HOT. DO NOT TOUCH THE BULB OR SHADE.
- Have students observe the container carefully and note any changes that they see. It might help to add a little smoke to the aquarium to help them see the circulation. (A few matches or incense sticks lit by the teacher, then blown out and quickly dropped into
- the box will work). Set up should look like this image:



Activity adapted from University Corporation for Atmospheric Research LEARN – Atmospheric Science Explorers – Teacher Resources – Cycles of the Earth and Atmosphere - https://scied.ucar.edu/WaterCycleActivity

http://www.ucar.edu/learn/

Assessment Activities:

- Using the data sheet below have students answer the questions as prompted by their observations.
- Challenge the students to use their understanding of the water cycle to explain a related phenomenon. Example: Put 1/2 inch or so of sand or gravel in a re-sealable plastic bag. Add 1/4 cup of water (color the water blue for easier visibility). Put it in a sunny window or under a bright light. The students should see evaporation, condensation, precipitation, and infiltration take place. They should identify that transpiration was not part of the system.
- Ask students to share examples of where they have seen water condensing and evaporating.
  - In the case of condensation, they should provide examples such as: water droplets forming on the mirror and walls in a bathroom where someone has just showered or bathed. Ask the students what the mirror and walls have in common that would allow water droplets to form. *(Water droplets will form on objects that are colder than the vapor created by the shower or bath.)* Ask the students why water droplets won't form on the person or a heat source such as a radiator in the bathroom. (*These objects are warmer than the steam.)* Other examples include, eyeglasses that fog up on a cold day when you walk inside.
  - In the case of evaporation, they should provide examples such as: a puddle that disappears over time, wet towels that dry out in the sun, etc.
- Review the water cycle with students and K-W-L discussion. Fill in the "L" aspect of the initial discussion.
- Have the students draw the water cycle in a diagram or ask them to construct a concept map of the water cycle and have students explain the various parts. It is recommended that these activities be completed in pairs or individually to get a more accurate evaluation of student understanding.

Wrap Up:

Re-engage the essential questions in a class discussion. Students should now be able to answer these questions in terms of how water moves through the water cycle.

Vocabulary

- **condensation**: the changing of water from a gas to a liquid
- **evaporation**: the changing of water from a liquid to a gas
- **precipitation**: the process by which water molecules condense to form drops heavy enough to fall to the earth's surface
- **sublimation**: the changing of water from a solid to a gas

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***Aquarius* Education & Public Outreach URL:** *http://aquarius.nasa.gov/*