**Lesson Plan: Green light means “go”**

**Learning Overview:** Just when we all thought we had evaporation all figured out, clever experiments shine a new light on old assumptions. A new study points to light having the ability to help sever bonds (a type of intermolecular force) between water molecules to boost evaporation. Learn how these findings support new scientific claims and challenge the old notion that light affects evaporation only indirectly, through heat generation.

**NGSS-DCI:** HS-PS2; HS-PS3; MS-PS3; MS-PS4.

**Paired Articles:**

*Science News:*“[Light, not just heat, might spur water to evaporate](https://www.sciencenews.org/article/light-water-molecules-evaporate-heat)”

Readability Score:10.4

*Science News Explores:*“[Heat makes water evaporate. Now it appears light can, too](https://www.snexplores.org/article/heat-light-water-evaporation)”

Readability Score: 7.5

**Directions**: To engage students before reading the article, share with them [this PHET simulation demo](https://phet.colorado.edu/sims/html/states-of-matter/latest/states-of-matter_all.html) (selecting water and adding enough “heat” to make some molecules break away from other, or evaporate). Then have students answer the “Before Reading” questions as a warmup in class or for homework. Now ask students to read the online *Science News* article “[Light, not just heat, might spur water to evaporate](https://www.sciencenews.org/article/light-water-molecules-evaporate-heat).” Afterward, have them answer the “During Reading” questions. As an optional extension for deeper analysis on proportions and relative values, have students discuss the “After Reading” questions. This article also appears in the December 16 & 30 double issue of *Science News*. *Science News Explores* offers another version of the same article written at a middle-school reading level.

**Before Reading**

1. Before viewing the simulation, think about a glass of water sitting on your counter for five days. What changes can you observe?

*The water evaporates, and some of it appears to vanish.*

2. During evaporation, what happens to the states of matter? Do you think this is a physical or chemical change? Explain why.

*During evaporation, water changes from a liquid phase to a gas. This is a physical change, because the molecular structure of water stays the same, but the spacing or density of the molecules changes.*

3. Watch the simulation. Explain what happens to a water molecule as it evaporates.

*When water evaporates, the individual water molecules separate from one another, but the molecules themselves remain intact.*

4. What action might you take if you wanted to speed up the evaporation of water? What does the simulation allow you to control to change the speed of evaporation?

*Answers will vary. Increasing the water's temperature would increase the evaporation rate, as would increasing the exposed surface area and exposing the water to windy conditions. The simulation allows you to control heat.*

**During Reading**

1. What are photons?

*Photons are individual particles of light.*

2. What do the study’s new findings suggest about the impact of photons on the bonds between water molecules?

*Photons might sever bonds, or intermolecular attraction forces, between water molecules.*

3. How does added heat affect the rate of evaporation?

*Added heat increases the rate of evaporation.*

4. Before these findings, what did scientists believe about the impact of light on evaporation rates?

*Before these findings, scientists believed that light only impacted evaporation rates indirectly, by contributing heat.*

5. In the new study, researchers shone light on various hydrogel samples. How did their measured rates of evaporation compare with what they expected?

*Their measured rates exceeded the hypothetical rates of evaporation.*

6. The study’s findings suggested that different wavelengths of light impacted the water differently. Which wavelength — or color of light — stood out in the study?

*Green light produced the highest rate of evaporation.*

7. What evidence did Janet A.W. Elliott point to that supported the claim that added heat alone could not account for the differences seen between samples exposed to different colors of light?

*Janet A.W. Elliott pointed to study results showing that when just a heater was used — and therefore, heat alone was applied — there was no accelerated evaporation.*

**After Reading**

1. Your best friend attempts to explain evaporation, but you notice that their explanation contains an error. Your friend says, “When water evaporates, the hydrogen and oxygen atoms in the water molecules all break apart, and that is how the water turns from a liquid to a gas. Find the error in your friend’s explanation and write out a response that would address and correct that error.

*When water evaporates, the individual water molecules remain intact. However, the forces that connect water molecules to one another break, and that’s how water turns from a liquid to a gas.*

2. Before this study, scientists believed that light “indirectly” affected water's evaporation rates. However, after this study, scientists realized that light might also have a “direct” effect. After reading this story, consider the difference between an indirect effect and a direct one. If an action — such as shining a light on water — directly impacts a result, what does that mean? How does that direct impact differ from an indirect impact? Point to evidence from this story that supported the scientists changing their position regarding light's direct vs. indirect impact on water evaporation.

*To say that an action directly impacts something is to say that the act caused the result. However, to say that an action indirectly impacts something is to say that the action set in motion a series of changes that led to the observed result. Answers will vary regarding supporting evidence, but students may refer to the discrepancy between the observed evaporation rates and the expected ones based on calculations with heat input.*