	LESSON PLAN - Does adding energy increase the rate of evaporation?
Standards	MS-PS1-4. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed. DCI PS1.A Structure and Properties of Matter ● Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. ● In a liquid, the molecules are constantly in contact with others, in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spread and may vibrate in position but do not change relative locations. ● The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter.
Vocabulary/ Key concepts	Evaporation ● Evaporation occurs when molecules in a liquid gain enough energy that they overcome attractions from other molecules and break away to become a gas. This happens at the surface of a liquid ● Adding energy increases the rate of evaporation. ● To conduct a valid experiment, variables need to be identified and controlled. Vaporization ● Vaporization occurs when molecules in a liquid gain enough energy that they overcome attractions from other molecules and break away to become a gas.
Objective	Students will be able to identify and control variables to test to see if heating water affects the rate of evaporation.
Supplies	2 quart- size zip-closing plastic storage bags Hot water (about 50°C) Room-temperature water 2 squares of brown paper towel 2 droppers Computers Ruler Lab sheets google doc version google form version data chart for google form

Bell Ringer	What is evaporation video What allows evaporation to happen?
Class work	Lab Procedures 1. Add room temperature water to a zip-closing plastic bag until it is about 1/4 filled. Get as much air out as possible and seal the bag securely. Lay the bag down flat. 2. Add hot tap water to a different zip-closing plastic bag until it is about 1/4 filled. Get as much air out as possible and seal the bag securely. Lay the bag down flat. This bag will serve as an energy source. The bag with the room-temperature water will serve as the control. 3. Place 2 pieces of paper towel on your table. You and your partner should each use a dropper to place 1 drop of room-temperature water in the center of each piece of paper towel at the same time. 4. Allow the drops to spread for about 5-10 seconds until they don't seem to be spreading any more. Take measurement of size of the drop spread. 5. At the same time, place one paper on each bag. 6. Observe every minute, and take a measurement. Compare the amount of water on each paper towel. (Remind students to not touch the drop as they measure because their body will add heat to the towel.) (Students should find that the water mark on the hot water bag should disappear faster than the mark on the room temperature water bag. This should take less than 5 minutes.} While waiting for the evaporation to take place, discuss the experimental design. How did we control variables? Why did we use the same type of paper towel for each sample? Why did we put the same amount of water on each piece of paper towel? Both drops of water on the paper towels were originally the same temperature. Was this a good idea? Why did we put the drops on the paper towel at the same time in the same area? {The type of paper towel material, amount of water, initial temperature of the water, and where the water is placed on the paper towel may all have an effect on the rate of evaporation. All these different factors are *variables* in the experiment. All these variables need to be kept the same so that the experiment is as fair as possible.} Why did we place one paper towel on a bag filled with room-temperature water? {Even the surface each paper towel is placed on should be the same. This is why one paper towel is placed on a room-temperature bag instead of on a room-temperature table or desk. The only difference should be the amount of energy the paper towels are exposed to. Be sure students understand the purpose of the control. The control is necessary because if there was only one sample that was heated, there would be nothing to compare it with. There would be no way of knowing whether adding energy made any difference in the rate of evaporation if there wasn't another sample to compare it to that was *not* heated.} Have students record their observations on their data sheets. Does adding energy increase the rate of evaporation? How do you know? (Yes. We can say that heating water increases the rate of evaporation because the drop of water that was heated evaporated first. Since the experiment controlled variables, heating water must increase the rate of evaporation.)

	Knowing what you do about energy and molecular motion, why do you think the water that was heated evaporated faster? (Students should remember that adding energy increases the motion of molecules. They should realize that the water molecules on the paper towel on the warm bag are moving faster than the ones on the room-temperature bag. Students should conclude that more of these faster-moving molecules break away from the other molecules and go into the air.)
Notes	

Adapted from ACS.org