LESSON 7: How can I make new particles from old particles?

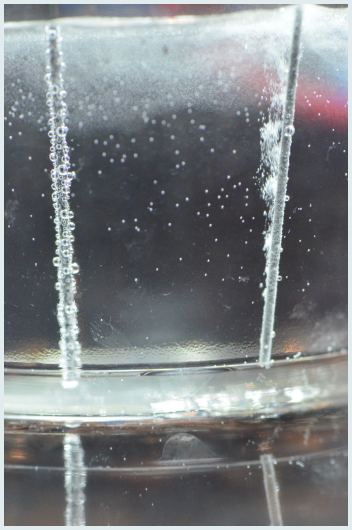
PREVIOUS LESSON

We developed a new way to put the pieces together from what we figured out in Lessons 1-5, using an input/output table. We identified an unanswered question about where the particles that make up the substance(s) of the gas came from and individually developed a model to try to explain this.

THIS LESSON

INVESTIGATION

1 day



We develop our model for making new particles from old particles using manipulatives (printed shapes on cards). We read about what Dalton and other scientists did to see if adding energy to water could form new particles. We carry out two of their investigations: (1) adding energy to water by heating the water and (2) adding energy to water with electricity. We argue that in both cases a gas is produced by adding energy to water. We argue that in both cases, we can figure out if there are new particles in the gas bubbles that form by testing the properties of those gases.

NEXT LESSON

We will carry out an investigation on the flammability of the gas produced by heating water. We will collect data on the mass and volume of this liquid that formed from that gas. We will argue that the resulting property data indicates that the gas we collected is made of the same particles that were in the water we started with.

BUILDING TOWARD NGSS

MS-PS1-1, MS-PS1-2, MP-PS1-5

WHAT STUDENTS WILL DO

Ask questions (through the use of models and gathering information from text) to determine how particles of matter in old substances could interact to produce new substances by combining or rearranging parts/particles (patterns) of the old substances.

WHAT STUDENTS WILL FIGURE OUT

- When new substances form from old substances, the particles of old substances might break apart and/or stick together to form new combinations of particles.

Lesson 7 • Learning Plan Snapshot

Part	Duration	Summary	Slide	Materials
1	15 min	**NAVIGATION: MANIPULATING IDEAS** Students work with a partner to share ideas from the last class period and work with manipulatives to test their ideas for making new substances from old substances.		1 copy of *Shapes*, scissors, tape, glue sticks, computer and projector,
2	13 min	**READING: A LOOK BACK IN HISTORY** Students read about James Dalton and other scientists' historical investigations and questions as they try to figure out how new particles can come from old ones.	C	*Dalton's Investigations*,
3	12 min	**GETTING GAS FROM A LIQUID** Record observations of what happens when electrical energy is added to water (electrolysis) and of what happens when thermal energy is applied to water until it boils.	D-E	Adding Energy to Water
4	5 min	**NAVIGATION: TURN AND TALK** Turn and talk to a partner to discuss predictions about what gas(es) were produced in the lab and suggest tests that would allow for gathering evidence to determine this.		

End of day 1

Lesson 7 • Materials List

	per student	per group	per class
Adding Energy to Water materials		• 1-9V battery • 1-battery clip • 2-wire leads with alligator clips on each end • 2-9mm 2B graphite pencil leads • 1-9 oz. clear cup • salt water from a gallon (or tap water if the water is relatively hard) • painters tape	• 4-400ml beakers • 4 hot plates • water
Lesson materials	• 1 copy of *Shapes* • scissors • tape • glue sticks • science notebook • *Dalton's Investigations*		• computer and projector

Materials preparation (15 minutes)

Review teacher guide, slides, and teacher references or keys (if applicable).

Make copies of handouts and ensure sufficient copies of student references, readings, and procedures are available.

Day 1: Adding Energy to Water

- **Group size:** 3
- **Setup:**
  - Prepare a gallon of water for students to use to test adding electrical energy to the water (prepare one gallon of this solution for every two classes). Distilled water will NOT work at the low voltages we are using.
  - Add 135g of epsom salt (magnesium sulfate) to the gallon of water and stir/shake it up. You will provide 100 mL of this liquid to every group. Don't introduce the idea that there is also epsom salt dissolved in the water. Also, do not say that ions in the water help these bubbles form when exposed to low amounts of electricity, as this is an idea that is beyond grade band.
  - Test this solution following the procedure outlined in *Adding Electrical Energy to Water* to confirm that it produces bubbles before giving the solution to the students.
- **Safety:**
  - Follow the same safety guidelines that the students will when you test the lab.
  - Wear safety goggles.
  - Don't connect to the battery until you have completely set up the system.
  - Don't allow the two wires, alligator clips, or pencil leads to come in contact with each other. They will become hot quickly.
  - Do not allow the battery to come in contact with the water.
  - Disconnect the clip from the battery as soon as you have made observations.
- **Storage:**
  - Store all batteries in separate locations.
  - Batteries will last longer when stored in a freezer.
  - Dry the ends of the batteries if they get wet, to prevent rusting. If the alligator clips become rusted or oxidized (identifiable by a brownish-orange color) they tend to no longer conduct electricity with the items with which they come into contact. Here is how to clean them off:
    - Submerge the ends of the clips in soda for a couple of hours.
    - Remove the clips from the soda and scrub their ends with a wire brush, steel wood, or toothbrush.
    - Dry off the ends immediately with a cotton swab or paper towel.
- **Disposal:**
  - When alkaline batteries are depleted, they can be safely disposed of with normal household waste.

- Prepare 4 stations with hot plates and glass beakers to boil the water and collect the water vapor for student observations. If you only have one hot plate, prepare a single, large station where multiple sets of students can view the hot plate from multiple sides.

Lesson 7 • Where We Are Going and NOT Going

Where We Are Going

In the previous lesson, students were left wondering how new particles are made. In this lesson, students model their ideas about how these new particles can come from old particles. This will provide early reinforcement of the idea of conservation of mass. This idea will be revisited several times. Students will learn that Dalton and other scientists tried to see if they could use energy (thermal and electrical) to split the particles of water. Students will do the same and figure out that splitting particles with either thermal or electrical energy produces a gas.

Where We Are NOT Going

In this lesson, students do not figure out what kind of gas results from boiling and from electrolysis--they will figure that out in the next lesson.

LEARNING PLAN for LESSON 7

1 · NAVIGATION: MANIPULATING IDEAS

15 min

MATERIALS: 1 copy of *Shapes*, scissors, tape, glue sticks, science notebook, computer and projector

Work with manipulatives with a partner . Show **slide A.** Have students turn to their recorded ideas from the end of the previous class. Have students share their ideas with a partner. Hand out the shapes from *Shapes*.
Say, *You had some ideas about how to make new substances out of the beginning substances. Share your ideas with a partner and then work with these manipulatives to agree on a way to represent your ideas. I have tape, glue, scissors, and additional copies of these shapes. Let me know if you need anything else to represent your ideas. Once you have decided how to represent your ideas, each of you should glue the manipulatives in a new page of your notebook to show what you decided could be happening. Label and use words to make your ideas clear. You have 8 minutes to do this task.*✱

ADDITIONAL GUIDANCE

It is most likely that the students will suggest taping or gluing particles together to make compound particles (clusters of smaller particles that are attached to make a bigger particle). When you see groups doing that, ask them if they think the opposite can also happen. Can these larger compound particles be broken apart into smaller pieces?

It is also possible, though less likely, that students will suggest cutting up one of the shapes provided (e.g. cutting a circle in half). At this point, such an idea is a productive one, as it raises the idea of which is the smallest particle of matter and can they be broken apart. If you see a group do this, ask them if they think the opposite can also happen. Can these smaller pieces be connected back together to make larger particles? Also ask them if they think there is a piece of matter that is so small it cannot be further broken apart.

Share ideas. Have a pair of students volunteer to share their ideas and show their representation. If you have a document projector, us it to display their notebook so it is easy for the class to see. After the first student pair shares, ask, *Did a group have a different idea about how this works?* Allow groups to share until 2-3 different ideas surface.

Discuss student ideas and link to upcoming reading. Show **slide B.** Say, *Some of you had ideas about sticking particles or pieces of particles together. Wait! Could that really happen? Can particles be put together? And, if you can put them together to make a bigger compound particle that is a cluster of smaller particles, can that bigger particle be split back apart into the smaller pieces it is made of? Let's keep track of this new model idea and see how we might get evidence for whether or not this is possible.*

2 · READING: A LOOK BACK IN HISTORY

13 min

MATERIALS: *Dalton's Investigations*, science notebook

Set up for the reading. Show **slide C.** Distribute *Dalton's Investigations* to each student. Ask students to have a pen or pencil to use as they read.

Link to the reading by saying, *As it turns out, famous scientists had some of the same questions that you have had. Let's read and find out what they did next to learn more. Maybe we can try out some of their ideas to answer our questions about the bath bomb.*

Give instructions for active reading. Tell students that as they read, they should keep track of ideas or questions they have by writing them on the handout. They can write them in the margins or anywhere else there is room. They should underline questions that Dalton had that are similar to their own questions. They should circle any investigations they think the class should try.

Tell them to answer the questions at the end of the handout when they finish. They can use the back of the page if they need more room to write.

ASSESSMENT OPPORTUNITY

See the assessment guidance for key things to look for as students engage in annotating this reading and things you can do if you notice students struggling with asking and identifying questions as they interact with this text. You may want to collect this reading from students as they set up their investigations, or right before the end of the period, so you can assess each student's progress in meeting the lesson level performance expectation.

Allow time for reading and recording responses. Give students 10-13 minutes to read and record their responses and notes. Once they are done, lead a short discussion of the reading to summarize. Use the example dialog to guide the discussion.

Suggested prompts	Sample student responses	Follow-up questions
What ideas did you think of or what did you notice while reading about Dalton?	*I thought it would be fun to try the experiments that added energy to a substance.*	*What if we tried that with water, what do you think would happen?*
What other ideas did you think of?	*I thought it was neat that a famous scientist had the same questions that we do.*	*What were some examples?*
Did you have any other ideas or wonderings?	*I wonder what happens when you put electricity through water.*	*What do you think will happen; what are your predictions?*
How will we know if the heat or electricity produces anything new?	*We can test the properties!* *If we have a substance with different properties then we have something new!*	*What properties would you test for?*

3 · GETTING GAS FROM A LIQUID

12 min

MATERIALS: Adding Energy to Water, science notebook

Set up the investigation. Say, *You made some predictions about what gases are produced by adding energy to water in different ways. You also suggested we test properties to see if anything new is produced when we do this. I also heard some of you say you wanted to try it--I have the lab set up so let's try it out!*

Show students the heating stations. Show **slide D.** Tell students that you have started heating--or adding thermal energy to-- water at 4 stations around the room and the water will soon boil. Start heating your water. Tell students you have also figured out a simple way to add electrical energy to water. Show students the materials: a 9V battery, a battery clip with wires, alligator clips, two pencil leads, and a cup.

Tell students, *I have a protocol for using this equipment to add energy to water using electricity. This is a quick set up, so follow the protocol and make some observations of what happens in the system. Be sure to look for any evidence of gases being produced.*

Assemble students into groups of 3. Show **slide E.** Distribute *Adding Electrical Energy to Water* and ask them to gather the materials. Also, tell them not to begin until you have gone over some of the safety considerations.

SAFETY PRECAUTIONS

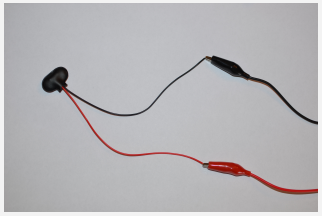
After students have gathered materials, get their attention and emphasize these safety considerations for their lab:

- Wear safety goggles.
- Don't connect to the battery until you have completely set up the system.
- Don't allow the two wires, alligator clips, or pencil leads to come in contact with each other. They will become hot quickly.
- Do not allow the battery to come in contact with the water.
- Disconnect the clip from the battery as soon as you have made observations.

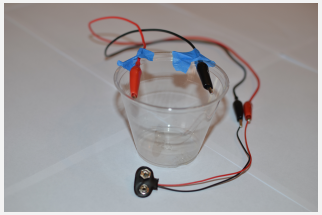
Protocol for investigation: The students will follow the protocol below to complete the investigation.

Prepare your system.

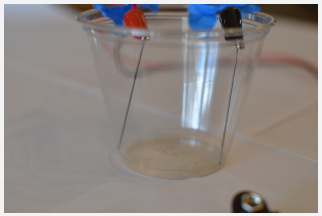
Attach an alligator clip to each end of the two wires in the battery clip.



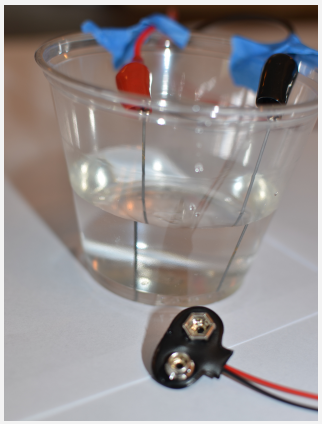
b. Tape the two wires about 2 inches apart on the top edge of a clear plastic cup.



c. Attach a pencil lead to each alligator clip so that the lead extends to the bottom of the cup.

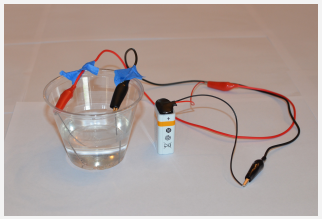


d. Get water from the container your teacher has available. Add water to your cup until half of the pencil lead is covered with water.



e. Carefully attach the battery clip to the top of your 9V battery. Look carefully at the clip and use the small snap to attach the clip to the larger terminal on the battery.

Your complete set up should look like this.



2. Title a new page in your notebook: Observations of Water: Adding Energy by Adding Electricity

3. Record observations in your notebook, paying close attention to what is happening at the location of each pencil lead.

4. Observe for at least 2 minutes.

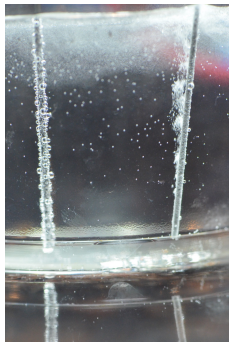
5. Draw a line under your last observation and record a new title: Adding Energy by Adding Thermal Energy

6. Make observations of the boiling water at one of the stations that your teacher has prepared. Record these in your notebook.

Record observations. Monitor students as the set up the electrolysis apparatus and make observations.✱ Students should spend no more than 5 minutes doing this. Students should then observe one of the boiling water stations you have set up. Students will see both systems again, so these are simply initial observations to confirm that gas is being produced in both systems.

ADDITIONAL GUIDANCE

When the wires are hooked up to the battery, students will see a stream of very tiny bubbles rising from along the entire length of each pencil lead that is submerged in water.



4 · NAVIGATION: TURN AND TALK

5 min

MATERIALS: science notebook

Turn and Talk. Show **slide F.** Once students have recorded some observations of both systems, have them sit with a partner and discuss the following questions. They should record their best ideas in their notebooks.

- What substances do you think are in the gas bubbles? Is it the same substance in both systems?
- If we could capture the gas, what are some tests we could do to gather evidence to answer these questions?