LESSON 5: What gas(es) could be coming from the bath bomb?

PREVIOUS LESSON

We argued from evidence for what scientific principles we have established. We planned and carried out an investigation to test different combinations of substances from a bath bomb. We used these results to argue that two substances interact in water to cause gas bubbles, neither of those are gas at room temperature, and therefore, the gas produced must be a new substance.

THIS LESSON

INVESTIGATION

2 days

We brainstorm phenomena related to gases and identify some different properties. We analyze the data for common gases that includes their known densities and flammabilities. We test the flammability of air from the room, gas from the bath bomb, and helium gas. We carry out an investigation to see if gas from the bath bomb rises or sinks. We argue from evidence (density and flammability data) that the gas from the bath bomb can be narrowed down to three candidate substances.

NEXT LESSON

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

BUILDING TOWARD NGSS

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

WHAT STUDENTS WILL DO

Analyze and interpret the data for common gases to look for patterns used to identify an unknown gas by its characteristic properties.

Construct, use, and present an oral and written argument supported by the patterns in the results from density and flammability tests and the data on these properties from a set of known gases and the use of related scientific principles to support that claim.

WHAT STUDENTS WILL FIGURE OUT

- Density and flammability are properties.
- In high concentrations, gases that are non-flammable will extinguish a flame.
- Materials that are less dense float upwards when surrounded by matter that is more dense; materials that are more dense sink downward when surrounded by matter that is less dense.
- The gas from the bath bomb could be carbon dioxide, nitrogen, or argon.

Lesson 5 • Learning Plan Snapshot

Part	Duration	Summary	Slide	Materials
1	8 min	**NAVIGATION** Brainstorm other gas-related phenomena and discuss the properties of gases that students can use to help figure out what gas comes from a bath bomb.	A, B	poster paper, marker, computer and projector
2	7 min	**ANALYZE AND INTERPRET PROPERTY DATA FOR GASES** Analyze and interpret the property data for several common gases to determine that density and flammability are good properties to use to identify a gas.	C	poster paper, marker, computer and projector
3	12 min	**TESTING THE FLAMMABILITY OF OUR BATH BOMB GAS AND OTHER KNOWN GASES** Test the flammability of two known gases (helium and air in the room) and compare it to the gas produced from the bath bomb.	D - E	computer and projector, Flammability test for air vs. bath bomb gas
4	10 min	**INVESTIGATING AND PREDICTING DENSITY EFFECTS FOR THE GASES** Predict and test how helium will interact with a flame in two different situations. Add ideas about floating and sinking gases to the scientific principles poster.	F-G	poster paper, marker, computer and projector, Density of helium lab
5	8 min	**MAKING PREDICTIONS ABOUT THE GAS FROM A BATH BOMB** Make predictive explanations about the possible behavior of the gas from a bath bomb.	H-I	*My Predictive Explanations for the Gas from a Bath Bomb*, computer and projector
				End of day 1
6	10 min	**TESTING PREDICTIONS ABOUT THE GAS FROM A BATH BOMB** Test how gas from a bath bomb interacts with a flame above and below it. Update the progress tracker.	K	computer and projector, Testing the density and flammability of bath bomb gas
7	5 min	**UPDATING INDIVIDUAL PROGRESS TRACKERS**	K	*Some Common Gases*, *My Predictive Explanations for the Gas from a Bath Bomb*, Scientific Principle poster, Anchor poster, computer and projector
8	10 min	**NAVIGATION: ARGUING FROM EVIDENCE** Arrange students in groups of 3 and distribute the *Discussion Protocol* to each student. Give instructions, and then monitor groups for this task as they practice verbally giving evidence-based arguments.	L	*Some Common Gases*, *My Predictive Explanations for the Gas from a Bath Bomb*, *Discussion Protocol: Density and Flammability*, Scientific Principle poster, Anchor poster, computer and projector
9	3 min	**GETTING READY TO WRITE AN ARGUMENT USING EVIDENCE** Identify a key scientific principle and important science ideas to strengthen arguments around claims to identify the gas(es) that come from a bath bomb.	M	computer and projector
10	12 min	**CONSTRUCTING ARGUMENTS ABOUT THE GAS FROM A BATH BOMB** Write an argument that includes a claim supported by evidence and reasoning.		notebook paper, computer and projector
11	5 min	**NAVIGATION** Consider the new substance that is produced from the bath bomb (the gas) and how modeling it with particles could help advance our understanding.	N	computer and projector
				End of day 2

Lesson 5 • Materials List

	per student	per group	per class
Flammability test for air vs. bath bomb gas materials			• 2 Erlenmeyer flasks • 2 rubber stoppers • 5 bath bombs • 100 mL water • matches • helium tank or helium balloons.
Density of helium lab materials			• 1 Erlenmeyer flasks • 1 rubber stopper • 5 bath bombs • 100 mL water • matches • helium tank or helium balloons.
Testing the density and flammability of bath bomb gas materials		• plastic soda bottle and cap • water • 5 mini-bath bombs • matches • candle • small aluminum bread pan liner	
Lesson materials	• science notebook • *My Predictive Explanations for the Gas from a Bath Bomb* • *Some Common Gases* • *Discussion Protocol: Density and Flammability* • notebook paper		• poster paper • marker • computer and projector • Scientific Principle poster • Anchor poster

Materials preparation (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: Flammability test for air, helium, and bath bomb gas

- **Group size:** Whole class
- **Setup:** Watch https://www.teachersopensciedfieldtest.org/chemical-reactions to see how to do this lab. You will use a 500-mL flasks, a #7 stoppers with no holes, 5 mini bath bombs, and wooden matches in this demonstration.
- **Safety:**
    - Do not add more than the 5 recommended number of mini bath bombs to the flask. It may shatter if too much gas pressure builds up in it.
    - Make sure that you, the students that help you, and any other students near the demo are wearing goggles. Have a cup of water nearby to discard burnt matches and splits. You and the students assisting you should tie back long hair.
- **Disposal:** After the bath bomb is added to the water in the bottle, the liquid can be dumped down the sink.

Day 1: Density of helium lab

- **Group size:** Whole class
- **Setup:** Watch https://www.teachersopensciedfieldtest.org/chemical-reactions to see how to assemble the equipment and do this lab. This video shows how to use either a helium tank or pre-filled helium balloons to do this. If no helium is available, show this video to students in place of the live demonstration. You will use a 500-mL flask and one #7 stopper with no holes or a 250-mL flask and one #6 stopper with no holes, and wooden matches in this demonstration.
- **Safety:**
    - **Do not be tempted to allow students to breathe** in helium from the balloon or to do it yourself. This common party trick that makes your voice sound different can be very dangerous. Even though it is usually harmless and many students or adults have never had any ill effects from breathing in helium, it can result in unconsciousness, collapsed lungs, or even death. These effects are caused from breathing in high concentrations of helium by directly sucking on an open helium balloon or breathing directly from any helium source. The helium released into the classroom through these investigations is not sufficient to cause any ill effects. There are also abrupt temperature changes that occur in gases that rapidly escape canisters that can lead to tissue damage when the gas is inhaled.
    - Make sure that you, the students that help you, and any other students near the demo are wearing goggles. Have a cup of water nearby to discard burnt matches and splits. You and the students assisting you should tie back long hair.
- **Disposal:** Vent all the gas from the tank and remove the relief disc before taking the tank to a recycling center. Instructions on how to do this are available here: https://www.wikihow.com/Dispose-of-a-Helium-Tank
- **Storage:** Before storing the helium tank, close the valve on it by turning it 90 degrees. Your tank can fill approximately 40 balloons and should last approximately 2-3 years.

Day 2: Testing the density of gas from a bath bomb lab

- **Group size:** Small group
- **Setup**
    - Watch https://www.teachersopensciedfieldtest.org/chemical-reactions to see how to assemble the equipment and do this lab. Each group will use a soda bottle with a cap, a candle, a small aluminum bread pan, a small amount of water, 8 mini bath bombs, and matches.
    - An alternate procedure is provided in slide O that may produce more consistent results that those provided in slide J. Try the one in slide J and if it doesn't work, try the one outlined in slide O. If the procedure in slide O is more reliable students will need alternate supplies (freezer bag, 1 teaspoon of citric acid, 2 teaspoons of baking soda, a 15mL centrifuge tube filled with water, a candle, a small aluminum bread pan, and matches)/
- **Safety:**
    - Remind students to hold the lit match at least 1" above their bottles (or plastic bags), and do not put them closer. The plastic can melt or burn if the flame comes into contact with it.
    - Make sure students are wearing goggles. Have a cup of water nearby to discard burnt matches and splits. Students should tie back long hair.
    - Do not add more than the recommended number of mini bath bombs to the bottle. It may rupture if too much gas pressure builds up in it.
- **Disposal:** After the bath bomb is added to the water in the bottle, the liquid can be dumped down the sink.
- **Storage:** Pans, candles, bottles, and caps can be saved and reused across classes and years.

Lesson 5 • Where We Are Going and NOT Going

Where We Are Going

This lesson is focused on figuring out the identity of the gas that comes from a bath bomb. This is accomplished by using the properties of density and flammability for several common gases.

Students should be able to draw on their experiences with helium balloons and experiences with thinking about how the particle density of air changes with temperature in OpenSciEd weather unit 6.3 to reason whether helium will float or sink in air and how the reported density value for it in grams per ml (compared to air) is related to those predictions.

Students will narrow down ten possible candidate substances to three substances by the end of this lesson. The written explanation that students will construct at the end of this lesson targets a portion of MS-PS1-2. "Analyze and interpret data on the properties of substances before and after the substances interact to determine...." In this PE, students are trying to develop an argument for whether a chemical reaction occurred. While they will do this fully in future lessons, right now, they are developing a precursor argument that will become part of the foundation for that.

Where We Are NOT Going

Students will not calculate the density of a gas. They will compare relative densities based on evidence of sinking and floating of that gas in room air. Density will be calculated for different substances when they work with clear liquids in later lessons.

LEARNING PLAN for LESSON 5

1 · NAVIGATION

8 min

MATERIALS: science notebook, poster paper, marker, computer and projector

Turn and Talk about the previous lesson. Display **slide A**. Say, *With an elbow partner, discuss what evidence we collected that helped us know that the gas bubbles from the bath bomb were not one of the three substances we started with (baking soda, citric acid, or water). Then discuss what kind of gas you think it might be. Feel free to brainstorm multiple predictions.*

After a couple of minutes, have students share some possible gases it could be. Anticipated responses will be any gases that students already know. If students completed OpenSciEd Unit 6.3 on weather, they are likely to mention some of the gases that make up the atmosphere, such as nitrogen, oxygen, and carbon dioxide.

Lead a short discussion to help students see that using properties to find out what kind of gas is coming from a bath bomb could be a good next step.

Say, *We know that there is more than one type of gas in our world. If we want to figure out what gas is in those bubbles, we could try to identify it based on its properties and compare it to the properties of other gases in the world around us. But what exactly are some different properties of gases? That seems tricky to determine because gases are invisible. Let's pause here and try to try to think of some related experiences with gases that might help us figure out some properties they have that we could use to tell them apart.*

Consider related phenomena around gases. Display **slide B**. Ask students to title a new page in their notebook, "Gas-related Phenomena." Tell them to list any experiences they have had with different kinds of gases. These can be gases that are used in different types of systems to make different things happen.

Then after brainstorming for a couple of minutes, ask students to share ideas. Student ideas may include:

- gas in a balloon (helium),
- the Goodyear Blimp that sometimes appears at sports events,
- gas stoves to cook on,
- gas in grills or fireplaces, or
- the gas fizz in a soda.

After getting some of these examples, say, *These are examples where different kinds of gases are used to make different things happen. Let's talk more about how the gases used in these systems can make these things happen.* Use the following example prompts to elicit student ideas about the properties of gases.

Suggested prompt	Sample student response
How would you describe what these gases are doing in the balloon or blimp?	*They make it float.*
What you are describing is actually considered a property of a substance. It is called density. How have you used ideas related to density in your previous work related to gases in the weather unit (in OpenSciEd)?	*A batch/parcel of air can become denser or less dense than the surrounding air when it is heated or cooled.* *When the spacing between the particles in gas changes, its density changes.*

Suggested prompt	Sample student response
The density of gases can change based on temperature, but it remains constant when measured under the same conditions. So if we always measure it at the same temperature and in the same location, then it is a property of a gas. Are there any types of gases that you know of that should make things like a balloon float upward in the air because they are less dense than the surrounding air?	*Helium must be less dense than air because it makes balloons float upward.*
Do you think the gas from the bath bomb is less dense than air, as dense as air, or more dense than it?	*Accept all predictions*
Can you give examples of some other ways that the gases are used?	*Well, some of them are used for cooking, heating, or in some fireplaces.*
What is done to the gas in these examples to get it to provide heat?	*It is lit on fire.*
Can you use any gas for fuel in these systems or only some? Why?	*Some gases burn, but others don't.*

Adding properties to the Word Wall. Say, *What you are describing is actually considered a property. Does anyone know what it is called?* If students do not know the property of flammability, introduce the term now. Have a student write it on a sticky note and add it to the Word Wall as another example of a property. Flammability is a property of a material that describes how the material interacts with fire. A substance that is flammable can ignite a material at room temperature.
If density is not on the wall, write it on a sticky note too, and add it to the Word Wall as another example of a property.

Students may also suggest odor as a way to identify the gas because they may have smelled natural gas from a gas leak or they may remember that some bath bombs had an odor. Remind them that odor is considered a property. Tell them that natural gas has an odor because another substance is mixed into it that has a rotten-egg-like odor to aid in the detection of gas leaks--the natural gas itself is actually odorless. Ask students if all bath bombs had an odor and if they detected an odor when they reacted the baking soda and citric acid. They should realize that the gas that is produced from a bath bomb is odorless, and that the odor they sometimes smell must be from some other substance added.

Say, *Let's look at some of these properties of different gases and compare them.*

2 · ANALYZE AND INTERPRET PROPERTY DATA FOR GASES

7 min

MATERIALS: science notebook, poster paper, marker, computer and projector

Distribute *Some Common Gases* to students. Display **slide C**. Give students 2-3 minutes to look over the list of gases and share their noticings and wonderings verbally with a partner.

After students have had time to share with their partner, lead a short discussion to bring out their ideas.

Suggested prompts	Sample student responses	Follow-up questions
Will someone share one thing they noticed about this data?	*I noticed that it lists some gases that I've heard of and some that I haven't.*	*Which ones are new to you?* *Has anyone heard of that gas?* *What do you know about it?*
Will someone share another thing they noticed about this data related to each of these gases?	*I noticed that there are a lot of different densities listed on the sheet.*	*Can you give some examples of gases that are more dense than air?* *Can you give some examples of gases that are less dense than air?*
What else did you notice about the data?	*There are some gases listed here that say they will explode.* *There are also some gases that are not flammable and others that help things burn.*	*Can you give an example of each?* *Which gases are those?*
Does anyone want to share a wondering they had?	*I wonder what the gas from a bath bomb would do--would it explode?* *I wonder if we could test the gas from a bath bomb for its density and flammability and then maybe we can figure out what gas it is.*	*Do you want to try these ideas out?*

3 · TESTING THE FLAMMABILITY OF OUR BATH BOMB GAS AND OTHER KNOWN GASES

12 min

MATERIALS: Flammability test for air vs. bath bomb gas, science notebook, computer and projector

Brainstorming how we could test the gas from the bath bomb for these properties. As students share that they could use density and/or flammability to figure out what gas comes from a bath bomb, ask them for some suggestions for ways to trap the gas from a bath bomb. Also ask them for ways to compare the gas in the bath bomb to other gases in the table. Students will likely suggest bottles or bags.

Say, *OK, let's plan to trap some gas first and then check it for one of these properties. Let's start with checking its flammability, and then we can look at density after that. One thing that scientists often do when testing the properties of an unknown substance is to compare it the properties of some known substances. Such comparisons are called control conditions. This increases the reliability of the results for the unknown substance, since a comparison between the behavior of a known substance and an unknown substance can often reveal problems in the equipment you are using or in your experimental procedure. I have two gases we can use as a controls for this comparison. I have some helium gas we can use and we can use air from the room. Let's review safety guidelines for these flammability tests.*

Review safety guidelines for this demonstration. You will need two volunteers to help. Have students put their goggles on and gather around the demonstration area.

SAFETY PRECAUTIONS

Make sure that you, the students that help you, and any other students near the demo are wearing goggles. Have a cup of water nearby to discard burnt matches and splits. You and the students assisting you should tie back long hair.

Fill one flask with helium and one with room air.

Slide a soda bottle over the end of the helium tank nozzle. Tilt the bottom of the bottle upward to catch the escaping gas. Release helium into the bottle for four seconds.

Keeping the soda bottle tilted so that the opening is facing down, slide it off the helium tank nozzle and put the stopper on it. You can do the same using a helium-filled balloon to inject gas upward into the flask.

Put a stopper on a second flask that is filled with room air.

SAFETY PRECAUTIONS

Do not be tempted to allow students to breathe in helium from the balloon or to do it yourself. This common party trick that makes your voice sound different can be very dangerous. Even though it is usually harmless and many students or adults have never had any ill effects from breathing in helium, it can result in unconsciousness, collapsed lungs, or even death. These effects are caused from breathing in high concentrations of helium by directly sucking on an open helium balloon or breathing directly from any helium source. The helium released into the classroom through these investigations is not sufficient to cause any ill effects. There are also abrupt temperature changes that occur in gases that rapidly escape canisters that can lead to tissue damage when the gas is inhaled.

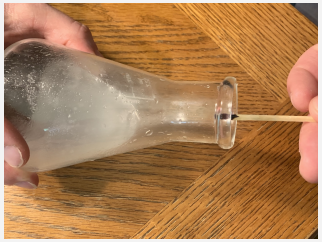
Predict the flammability results of helium and air. Show slide D. Explain that you are going to light a match and slide into each flask. Ask students to look back at their property data in *Some Common Gases* to make some predictions. Students should say the match put into the flask of room air should remain lit, but the one put into the flask of helium should go out.

Test the flammability of the helium gas and air.

Have a helper tilt a flask filled with air on its side holding from behind. Light a match and bring it about 6 inches from the corked end. Have another helper remove the cork. Quickly slide the lit match into the opening and hold it there for three seconds prompting students to notice the flame.

The flame will remain lit. Remove the match and extinguish it.

Have a helper tilt a flask filled with helium on its side holding from behind. Light a match and bring it about 6 inches from the corked end. Have another helper remove the cork. Quickly slide the lit match into the opening and hold it there for three seconds prompting students to notice the effect. The flame will immediately go out upon entering the flask.



ALTERNATE ACTIVITY	If no helium is available, show OP.CA.VID.L5.003 in place of first hand helium testing.

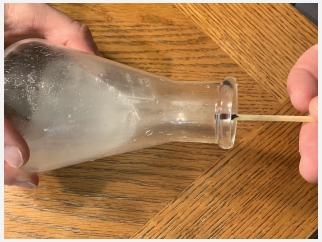
Discuss these results. Ask students why the flame went out in one but not the other. Students should say that *It is because of helium will not support a flame but room air will.*

Capture gas from a bath bomb and test its flammability. Remove the stoppers from both flasks you just used. Use the flask you had for the room air if you have no additional flask available for this next test.

Add about 50 mL of water to an Erlenmeyer flask, and then add 5 mini bath bombs to a flask

Let it bubble for a few seconds, and then seal it with a stopper.

Test the flammability the gas from the bath bomb. Light a match. Have a helper tilt the flask on its side holding from behind. Light a match and bring it about 6 inches from the corked end. Have another helper remove the cork. Quickly slide the lit match into the opening and hold it there for three seconds prompting students to notice what happens. The flame will immediately go out upon entering the flask.



Show **slide E.** Say, *Now that we have this results, we can use it to strike through all the gases that do not have that property on our list of candidates. Give students a few minutes to m***ark off gases from *Some Common Gases.*** They should be eliminating air, oxygen, hydrogen, methane, and propane

4 · INVESTIGATING AND PREDICTING DENSITY EFFECTS FOR THE GASES

10 min

MATERIALS: Density of helium lab, science notebook, poster paper, marker, computer and projector

Introduce the idea of testing density. Say, *OK, we tested the flammability of the bath bomb gas, but there was another property listed that we wanted to test. What was that other property?* Students should say density.

Say, *The last time you studied the density of gases was in your weather unit (OpenSciEd 6.3). In that unit, you learned that when a gas or liquid is more dense than the surrounding gas or liquid it sinks downward and when it is less dense than the surrounding gas or liquid it floats upward. Let's look at helium's reported density and make predictions about what helium would do if we released it from a container into the surroundings.*

Predict the behavior of helium. Display **slide F.** Discuss predictions as a class. Students should predict it will float upward. Say, *Let's test it.*

Fill one flask with helium and one with room air.

Slide a soda bottle over the end of the helium tank nozzle. Tilt the bottom of the bottle upward to catch the escaping gas. Release helium into the bottle for four seconds.

Keeping the soda bottle tilted so that the opening is facing down, slide it off the helium tank nozzle and put the stopper on it. You can do the same using a helium-filled balloon to inject gas upward into the soda bottle.

Say, *OK let's get ready to release it and see if it floats upward or sinks downward. Are you ready?* Wait about 10 seconds. Students are likely to raise a concern before you release the stopper, saying *how will we be able to tell which way it goes? Its invisible!*

If students don't object, then simply open the stopper on the flask. Wait about 10 seconds and then ask, did the release gas travel upward like you predicted? It is at this point that you will definitely get some objections from students, saying *how were we supposed to be able to tell which way it went? Its invisible!*

Suggest using its flammability as a way to test whether it is less dense or more dense than air. Say, *Good point. We need a way to detect whether the helium gas traveled upward or downward. We already know something about its flammability though. So if we opened a bottle filled with the gas and held a match in front of it then opened removed the cork, what should happen to the flame when the gas comes out of the bottle?* Students should say it would go out.

Share predictions. Show **slide G**. Give students a couple of minutes to discuss their ideas with a partner.

Say, *Let's test this ourselves to see if our predictions are correct, and then we will use what we figured out and try to apply it to the gas from the bathbomb.*

Test the flammability of the helium gas in each case.

Slide a soda bottle over the end of the helium tank nozzle. Tilt the bottom of the bottle upward to catch the escaping gas. Release helium into the bottle for four seconds.

Keeping the soda bottle tilted so that the opening is facing down, slide it off the helium tank nozzle and put the cap on it. You can do the same using a helium-filled balloon to inject gas upward into the soda bottle.

While still holding the bottle upside down, have a student light a match under the bottle as you remove its cap. Students should notice that the flame does not go out.

Now turn the bottle right side up. Ask a student to get ready to remove the cap. Light a match. Have the student remove the cap and move the match right over the opening of the bottle. The match will go out.

ALTERNATE ACTIVITY	If no helium is available, show https://www.teachersopensciedfieldtest.org/chemical-reactions in place of first hand helium testing.

Discuss these results. Ask students why the gas from the bottle extinguished the flames in one case but not the other. Students should say that *It is because of its density, and that if the gas floats upward, it will only put out a flame above it, not below it, because it won't fall downward out of the bottle.*

Updating the Scientific Principles poster. Add a density principle that says, "Less dense gases (and liquids) float upward when surrounded by denser gases (and liquids); and denser gases (and liquids) sink downward when surrounded by less dense gases (and liquids)."✱ Add this to the Scientific Principles poster. Help students connect back to what they may have seen in lesson 4 with oil floating on water, if this is something they noticed, asking them what this shows about the density of oil compared to water. Students should say it is less dense than water.

ADDITIONAL GUIDANCE	This is very similar to the principle that students developed in unit 6.3 of OpenSciEd (weather). In that unit, it was stated as "Less dense fluids float upward when surrounded by denser fluids, and more dense fluids sink downward when surrounded by less dense fluids." Students used the word fluids to refer to liquids and gases, and to describe similarities in their motion via convection. Students may suggest that word now (fluids). If they don't bring it up, then stick with the phrase "gases (and liquids)."

Introduce testing the bathbomb gas in a similar manner. Tell students that they will test the bath bomb gas in a similar manner tomorrow, but before they do you want them to make some predictions about what we could figure out about the gas from a bathbomb by doing a test similar to the one we just did, but with gas from a bath bomb trapped in a bottle or bag instead of helium gas.

5 · MAKING PREDICTIONS ABOUT THE GAS FROM A BATH BOMB

8 min

MATERIALS: *My Predictive Explanations for the Gas from a Bath Bomb*, science notebook, computer and projector

Making predictive explanations. Pass out a copy of *My Predictive Explanations for the Gas from a Bath Bomb*. Ask students to use this handout to make two different if-then statements that will describe what they could learn from testing the density and flammability of the gas coming from the bath bomb. Display **slides H and I t**o show the structure of the information that their prediction should have.✱ Remind students that they will need to use *Some Common Gases* as a reference as they record their predictions on *My Predictive Explanations for the Gas from a Bath Bomb*. Don't have students attach these predictions to their notebook because you will collect them at the end of the day and return them at the start of day 2.

ASSESSMENT OPPORTUNITY

Collect their predictions on *My Predictive Explanations for the Gas from a Bath Bomb* at the end of day 1. Look for these responses:

- If the gas from the bath bomb puts out a flame above it, that means it is __**less**____ dense than the room air, which has a known value between ___**1.160 to 1.161 g/L**_____. I know this because _____ **materials that are less dense float upwards when surrounded by matter that is more dense**_____. If evidence supports this prediction, it tells me that the gas from a bath bomb could be __**neon, helium, and/or carbon monoxide**_____.
- If the gas from the bath bomb puts out a flame below it, that means it is __**more**____ dense than the room air which has a known value between ___**1.160 to 1.161 g/L**_____. I know this because _____ **materials that are more dense sink downwards when surrounded by matter that is less dense**_____. If evidence supports this prediction, it tells me that the gas from a bath bomb could be __**nitrogen, argon, and/or carbon dioxide**_____.

If you notice students are struggling when they are forming these for the first time, you could pause the activity. Then talk through the responses and rationale for what they would put in each of the blanks on **Slide H**, together as a whole class for the first prediction. You could then have them individually write their understanding of what you just discussed, and have them try the same for the second prediction shown on **Slide I**.

✱ SUPPORTING STUDENTS IN ENGAGING IN CONSTRUCTING EXPLAINING AND DESIGNING SOLUTIONS

We want to help students develop the practice of arguing from evidence. These sentence stems give them scaffolding to properly use evidence, scientific principles, and reasoning to build a strong argument. Students will later construct an explanation that includes both qualitative and quantitative relationships between variables that predict the phenomenon of sinking and floating bubbles of gas. These sentence frameworks will help to scaffold this process that may be difficult for some students.

End of day 1

6 · TESTING PREDICTIONS ABOUT THE GAS FROM A BATH BOMB

10 min

MATERIALS: Testing the density and flammability of bath bomb gas, science notebook, computer and projector

Return student predictions. Hand back the copies of *My Predictive Explanations for the Gas from a Bath Bomb* you collected. Have students share their predictions on this sheet with a partner for a minute.

Investigate the gas from a bath bomb. Display **Slide J**. Review the first three bullets, asking students questions about safety related to these steps.

Suggested prompt	Sample student response
You will be using a plastic soda bottle instead of a glass flask. Why is it important to not get the lit match closer than 1" above the top of the plastic bottle? What can happen to plastic if a flame touches it?	*It could melt if the flame touches it.* *Or it could burn.*
What evidence do you know of that indicates that the gas from bath bombs is not flammable and/or won't explode?	*We tested it already with a match in a glass bottle.*

Say, *After testing the flame above the bottle for 2 seconds, you will get ready to test a flame below the bottle. Can anyone see a problem with testing this gas the same way we tested helium? One problem with our bottles is that they will have liquid in them, so we can't simply put a match right below them and open the lid without the liquid spilling out. In the next few steps, you will light a candle and place it in a pan below the bottle, then you will upcap the bottle and tilt the bottle sideways to pour out the gas in it. If the gas is more dense, then what should it do? You will be able to see if it puts out a flame below it without tipping out the liquid inside of it.*

SAFETY PRECAUTIONS

Make sure that you, the students that help you, and any other students near the demo are wearing goggles. Have a cup of water nearby to discard burnt matches and splits. You and the students assisting you should tie back long hair.

Do not have students add more than the recommended number of mini bath bombs to the bottle. It may rupture if too much gas pressure builds up in it.

ALTERNATE ACTIVITY

An alternate procedure is provided in slide O that may produce more consistent results. Try the original one and if it doesn't work, try using the one outlined in that slide instead, and replace slide J with slide O.

Monitor students in the lab. Give students about 6-7 minutes to collect their data from the lab.

7 · UPDATING INDIVIDUAL PROGRESS TRACKERS

5 min

MATERIALS: *Some Common Gases*, *My Predictive Explanations for the Gas from a Bath Bomb*, Scientific Principle poster, Anchor poster, computer and projector

Updating the list of possible gases. Display **Slide K.**

Tell class, *Use these results of your investigation and your predictions to narrow down the substances the gas form the bath bomb could be.* Cue students to look back through *Some Common Gases* and *My Predictive Explanations for the Gas from a Bath Bomb* and individually cross of candidates that they have now eliminated as they transfer their discoveries to their Progress Tracker.

8 · NAVIGATION: ARGUING FROM EVIDENCE

10 min

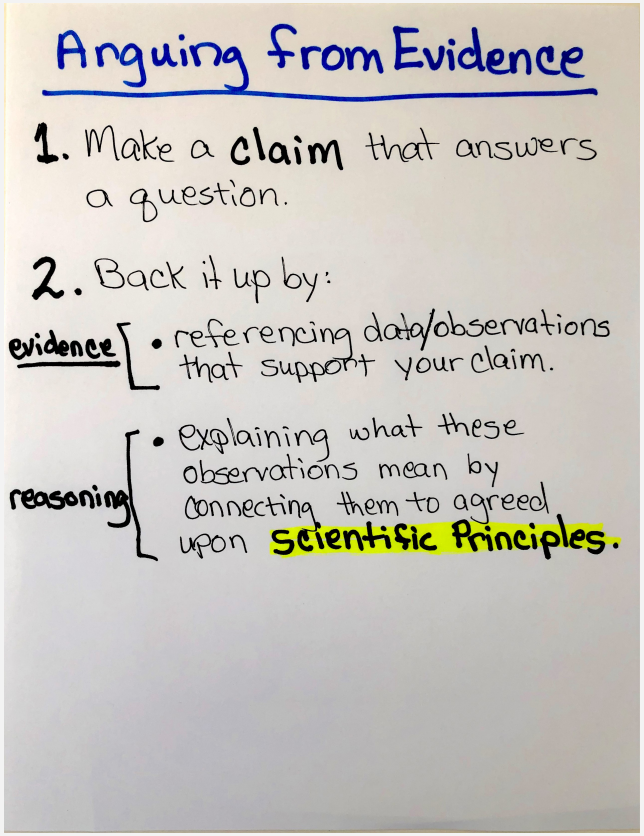
MATERIALS: *Some Common Gases*, *My Predictive Explanations for the Gas from a Bath Bomb*, *Discussion Protocol: Density and Flammability*, Scientific Principle poster, Anchor poster, computer and projector

Return student predictions. Pass back the student predictions they made on *My Predictive Explanations for the Gas from a Bath Bomb.* Have students attach their predictions to their notebook.

Divide the students into small groups. Arrange your students in groups of 4. Mix them in groups different from their lab group from the previous class. They will need:

- their notebooks turned to their last entry in the progress tracker,
- the data table from *Some Common Gases*,
- their predictive explanations from *My Predictive Explanations for the Gas from a Bath Bomb*, and
- the new handout, *Discussion Protocol: Density and Flammability*.

Set up the protocol. Display **slide L** and spend a few minutes as a whole class going over the protocol with students. Ensure that the anchor poster you made from Lesson 2 is clearly visible to all groups . Make sure they understand that everyone in the group will share their ideas in the form of making a claim about one gas that could be from the bath bomb or one gas it couldn't be. All students will participate in giving feedback to their peers. Have students practice snapping their fingers and lightly tapping their feet. Reserve at least 12 minutes for students to participate in this activity. Set a timer so that students know when a new classmate should offer their claims.



9 · GETTING READY TO WRITE AN ARGUMENT USING EVIDENCE

3 min

MATERIALS: computer and projector

Identifying overarching principles to call out in our argument. Use the Scientific Principles poster, and work together with the class to determine if there is one main principle they can use in a written argument that identifies the remaining possible gases that could come from a bath bomb. Use the dialog below as an example to guide your discussion.

Suggested prompts	Sample student responses	Follow-up questions
What has been helpful to you for identifying the gases that could be coming from the bath bomb?	*Density!* *Flammability!*	*What do these two things have in common?*
You say that these are both properties, and we have them as examples on our word wall. Is there a scientific principle that we can be sure to use that would help us in our argument?	*They are both properties, and we have one about properties--Substances have properties that can help us identify them (e.g., solubility, odor, state of matter at room temperature, melting point, density, flammability and color).*	*Is the gas from the bath bomb considered a substance?*
Can you think of other science ideas that we can use in our reasoning?	*The gas from the bath bomb sank down, so we could use gases that are more dense than air, which will sink in air.*	*Are there other science ideas or principles that we should draw on in our arguments?*

Review instructions for the task. Remind the class that the ideas on the Anchor Chart can be used to build a strong argument. Go over each part of the poster, reminding students about the important parts of a strong argument. Display the Anchor Chart and **slide M**. This slide has the question they should answer: *"What gas(es) could be produced by a bath bomb?"* Say, *Your written argument should be your claim to answer this question. You should use evidence and reasoning (using scientific principles and science ideas) to support your claim. Use this anchor poster to remind you of what is important.*

10 · CONSTRUCTING ARGUMENTS ABOUT THE GAS FROM A BATH BOMB

12 min

MATERIALS: science notebook, notebook paper, computer and projector

Give time for students to individually construct their arguments. Tell students where you want them to write their arguments, depending on how you want to gather their responses. If you want them to record their ideas in their notebooks, have them use a clean page and mark it so it is easy for you to find. Tell students that you will use this task as an assessment, so they should do their best work.

Encourage students by reminding them that they have had multiple chances to practice these arguments in small teams and with the whole class. Now it is time for them to write their arguments individually and "show off" what they have learned. Tell them that they can use the posters around the room, their notebooks, the data table, and any other material from the lessons as a resource to write their argument.✱

ASSESSMENT OPPORTUNITY	Use *Elements to look for in students' written arguments* for guidance on what to look for in their written argument.

✱ SUPPORTING STUDENTS IN THREE-DIMENSIONAL LEARNING

This is an opportunity for assessing students' engagement in all three dimensions of NGSS to explain a phenomena. It targets a portion of MS-PS1-2. "Analyze and interpret data on the properties of substances before and after the substances interact to determine...." In this PE, students are trying to develop an argument for whether a chemical reaction occurred. While they will do this fully in future lessons, right now, they are developing a precursor argument that will become part of the foundation for that. They are arguing for *what new substances could have been produced in the gas from the bath bombs*. In this assessment, students are using DCIs related to PS1.A: Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to

identify it. They are using the crosscutting concept of patterns (at a macroscopic scale), and they are developing an evidence-based argument based on their analysis and interpretation of data from laboratory experiments and known property information to determine the similarities and differences in findings.

11 · NAVIGATION

5 min

MATERIALS: computer and projector

Brainstorm Possible Explanations. Display **slide N**. Read through the questions together. Have students discuss these questions with a partner.

Then have a few students share their ideas. Accept all ideas.

Pause the conversation before the end of the period and say, *This is interesting to think about. Let's pick up here next time. I'd love to hear more ideas too. This seems like where we should pick up next time -- trying to really figure out what might be happening on a scale smaller than we can see.*

Additional Lesson 5 Teacher Guidance

SUPPORTING STUDENTS IN MAKING CONNECTIONS IN ELA

CCSS.ELA-LITERACY.W.7.1 Write arguments to support claims with clear reasons and relevant evidence.

- CCSS.ELA-LITERACY.W.7.1.A Introduce claim(s), acknowledge alternate or opposing claims, and logically organize the reasons and evidence.
- CCSS.ELA-LITERACY.W.7.1.B Support claim(s) with logical reasoning and relevant evidence, using accurate, credible sources and demonstrating an understanding of the topic or text.
- CCSS.ELA-LITERACY.W.7.1.C Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), reasons, and evidence.
- CCSS.ELA-LITERACY.W.7.1.D Establish and maintain a formal style.
- CCSS.ELA-LITERACY.W.7.1.E Provide a concluding statement or section that follows from and supports the argument presented.
- CCSS.ELA-LITERACY.W.7.2.C Use appropriate transitions to create cohesion and clarify the relationships among ideas and concepts.
- CCSS.ELA-LITERACY.W.7.2.D Use precise language and domain-specific vocabulary to inform about or explain the topic.
- CCSS.ELA-LITERACY.W.7.2.E Establish and maintain a formal style.

The above learning goals are the focus of the written argument that students produce at the end of day 3 of this lesson.

CCSS.ELA-LITERACY.SL.7.1.B Follow rules for collegial discussions, track progress toward specific goals and deadlines, and define individual roles as needed.
This is the focus of the discussion in the small group discussions on day 3 of this lesson. There is a discussion protocol to help transition the roles of each person in the group and contribute to the discussion in different ways.