1a. “Seeing” Particles of Matter

The Radon Project

Grade 5	Subject: Science	Time: 50-70 minutes

Strand/Standard: 5.2.1

Develop and use a model to describe that matter is made of particles on a scale that is too small to be seen. Emphasize making observations of changes supported by a particle model of matter. Examples could include adding air to expand a balloon, compressing air in a syringe, adding food coloring to water, or dissolving salt in water and evaporating the water. The use of the terms atoms and molecules will be taught in Grades 6 through 8. (PS1.A)

Lesson Performance Expectations

- Students will use a “cloud in a bottle” to learn how invisible particles of matter can create a visible “cloud”.
- Students will describe matter as made of particles too small to see.
- Students will use their model to describe how a cloud chamber creating its cloud tracks is similar and different from the cloud in a bottle.

Materials

Each group will need

- Thin plastic water bottle (16 oz)
- Rubbing alcohol 70%
- Cloud Chamber (optional)

Teacher Background Information

1. The water bottle experiment demonstrates condensation of water molecules around a molecule of rubbing alcohol. 70% rubbing alcohol is also 30% water. This model is very similar to how a cloud forms in the atmosphere when dust or smoke provides a nucleus for water to condense on when the air cools.
2. The squeezing adds energy to the system by compacting and warming the air in the bottle. When the bottle is allowed to expand, it cools and the condensation occurs.
3. A cloud chamber relies on rubbing alcohol also and a temperature exchange (the dry ice cools the air in the chamber). A radioactive particle traveling through the saturated alcohol solution triggers the alcohol to condense in trails of visible particles. Both these videos are far beyond the level that should be presented in a 5th grade classroom but they will aid in your understanding of the cloud chamber if you wish to know more
   - ▶️ How to Build a Cloud Chamber!
   - ▶️ How to Reveal Subatomic Particles at Home | NOVA
4. Answers to questions on student sheet:
   - **Was the bottle ever empty?** No, it always had invisible particles in it. Air is invisible.
   - **When do particles become visible?** When they clump together.
   - **What is all matter made of?** Very small particles.

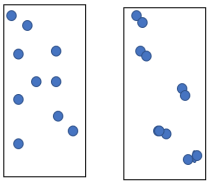
Student Background Knowledge

- Students should have been introduced to the concept of matter being made of particles that exist as solids, liquids or gasses..
- Students may know that the particles of matter are not all alike.

Teacher Directions

A standards-based lesson engages students' curiosity, interest and motivation to learn more. Time and space for the students to experience the phenomenon and ask questions is essential. The student sheet provided below provides guidance but is only one example of how students might respond.

1. Provide copies of the Student Sheet for each student.
2. The phenomenon can be demonstrated or better yet, student groups can each have a bottle and try it.
3. Directions for the phenomenon can be found below or here: https://playingwithrain.com/make-a-cloud-in-a-water-bottle/.
4. Allow time for students to make observations and ask questions. They should write questions down.
5. Each student should draw the particles (as dots) to show what they are doing in the empty bottles on their student sheet. Allow time for students to share their models with each other.



(Figure 1) Sample interior of flasks

6. Conservation of matter is taught in 8th grade so you might only suggest that the same number of particles should be in both bottles. A good discussion might be the "why".
7. If a cloud chamber is available, give students a chance to watch it work. If one is not available, this video can be substituted: https://www.youtube.com/watch?v=e3fi6uyyrEs
8. A detailed discussion of radioactivity and subatomic particles is not needed.
9. Follow up with a discussion of the original questions the students had.

Assessment of Student Learning

1. Why is the air in your classroom invisible? Choose two.
    a. Air is not made of particles.
    b. Air particles are invisible.*
    c. Particles of air are not clumped together.*
    d. Particles of air are very close together.
2. Which of the following is another way to model the particles in air? Choose two.
    a. Blow up a balloon.*
    b. Crack a rock in two.
    c. Wave your hand to fan your face.*
    d. Write with a pen.
3. What is another example of particles clumping together when they are cooled? Choose two.
    a. Steam rising from a sidewalk after a rain.
    b. Water dripping down the outside of a cold glass.*
    c. Seeing your breath on a winter day.*
    d. Breathing hard after running a mile.

Lesson Extension: Career Connections

Students research clouds and cloud formation to discover what happens when it rains.

Student Sheet Name: _____

“Seeing” Particles of Matter

Phenomenon/Observations

Follow your teacher's instructions to add rubbing alcohol to the plastic water bottle. Twist the bottle in two, let it untwist quickly and describe what happens here:

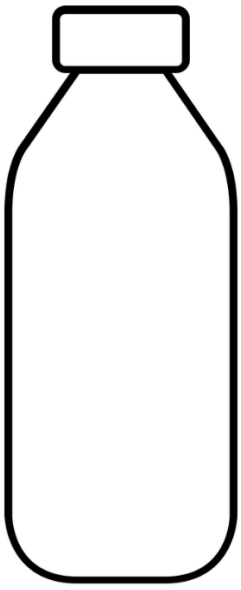
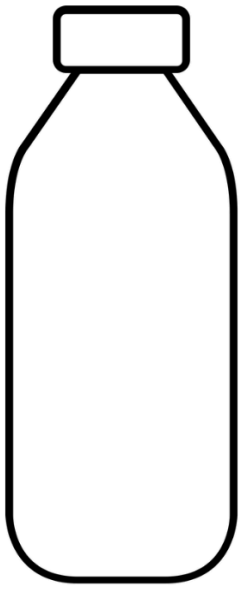
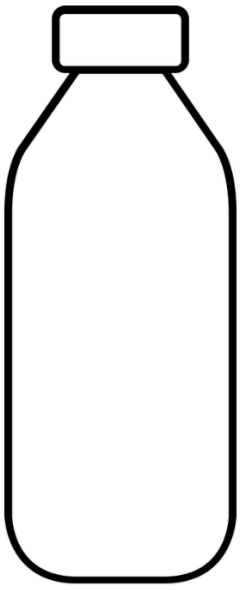
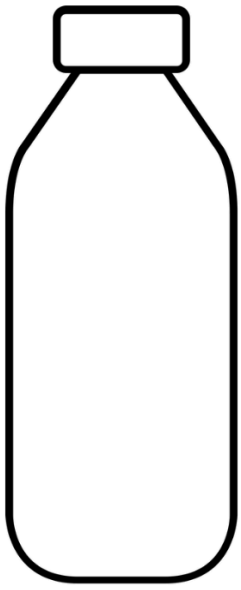
What questions do you have?

1.

2.

Making a model

Draw what you think the particles are doing before and after squeezing and releasing.

Prediction		Actual	
Bottle before squeezing	Bottle after squeezing and releasing	Bottle before squeezing	Bottle after squeezing and releasing
			

Video

Watch the video or demonstration of the cloud chamber. There are some similarities and differences between the “clouds” in the cloud chamber and in the bottle.

Write what you think are the same:

Write what you think are different:

Analysis:

1. Was the bottle ever empty?

2. When do particles become visible?

3. What is all matter made of?

4. Revisit your questions from the phenomenon. Answer them below.

How to Make a Cloud in a Water Bottle

Supplies: plastic water bottle, rubbing alcohol

Summary

1. Pour rubbing alcohol into an empty water bottle.
2. Put the lid on the bottle and shake it.
3. Twist the bottle.
4. Release the pressure to form a cloud!
5. Increase the pressure again to make the cloud vanish!

Step 1: Pour rubbing alcohol into an empty water bottle

- Get started by adding just a tiny bit of Rubbing Alcohol into the bottom of an empty water bottle.
- You just need enough rubbing alcohol to cover the bottom of the bottle.
- If the bottle still has water in it, you will want to empty it out first before adding the rubbing alcohol.
- Don't worry if a few drops of water are left in the bottle though. This will actually help add some moisture to make an amazing cloud!

Step 2: Put the lid on the bottle and shake it

- Now screw the cap onto the bottle and shake the bottle up for a few seconds.
- This will coat the inside of the bottle with a layer of rubbing alcohol.
- Some of the water in the rubbing alcohol will evaporate and turn into invisible water vapor during this process.

Step 3: Twist the bottle

- It's time to increase the air pressure inside the bottle now. To do this, hold the bottle with both hands and twist your hands in opposite directions.
- Twisting the bottle up will force the air inside into a smaller area than before and this will increase the heat in the bottle!

Step 4: Release the twist to form a cloud

- After the pressure has increased in the bottle, quickly decrease the air pressure and watch a cloud form inside the bottle!
- You can decrease the twist by quickly releasing your grip and letting the bottle untwist on its own.
- This will cool the air to form a cloud!