Lesson 3-2
What is that smell?

Lesson Overview

1. Timeframe: 3 class periods

2. Learning Performances
   Students develop models to describe that gas is a form of matter and is made of particles that are too small to see and that move freely.

   Students collect data to serve as evidence that gas has weight that can be measured.

   SEP *Planning and carrying out an investigation*: *Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.*

   SEP *Using mathematical and computational thinking*: *Describe, measure, estimate, and/or graph quantities such as area, volume, weight, and time to address scientific and engineering questions and problems.*

   SEP *Developing a model*: *Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution.*

   DCI *PS1.A*: *Matter of any type can be subdivided into particles that are too small to see, but even then, the matter still exists and can be detected by other means.*

   DCI *PS1.A*: *A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects.*

   CCC *Scale, proportion, and quantity*: *Natural objects exist from the very small to the immensely large.*

3. Overview
   This lesson introduces a new sub-question, *What is that smell?* This lesson builds on Lesson 2-3's understanding of solids and liquids by similarly introducing gases as matter made of particles too small to see.

   Day 1
   - Teacher uses students' questions from the end of the previous lesson to introduce the new sub-question to investigate, *What is that smell?*
   - Prompted by a scented material in the classroom, students ask questions about smell/air/gas and add their questions to the DQ Board.

- Students develop individual models (Model: Gases).
- Students experience air as "something" by breathing deeply.

Day 2

- Students complete Investigation 1: Balloon by watching Video Lesson 3-2: Balloon and sharing observations to conclude that air is matter that has weight.
- Students complete Investigation 2: Syringe and answer questions to conclude that air is something.
- Teacher guides students to think of gas as made of particles too small to see, which move freely throughout the available space.

Day 3

- Students obtain information from a computer simulation about air pressure in Investigation 2: Syringe.
- Students revise individual models of gases based on investigations.

Materials

For each student:

- 1 Science and engineering notebook (SEN)
- 1 Pencil
- 1 Copy of Investigation 3-2: Gases (Day 2)
- 1 Copy of Model: Gases (revised) (Day 3)

For each group:

- 1 Syringe (any size, approx. 10 mL, with pin removed)

For the class:

- 1 Container of scented material
- 1 Hand-held fan (optional)
- 1 Video Lesson 3-2: Balloon (Day 2)
- Phet Simulation: https://phet.colorado.edu/sims/html/states-of-matter/latest/states-of-matter_en.html

Teacher Background: Connecting Investigations to Gas as Particles

The investigations on Day 2 lead students to an understanding that gas is something and is made of particles that move and bounce off one another or the surfaces of the container. Because there is a lot of space between them, the same amount of air can be compressed into a smaller volume, and the effect of that is to raise the pressure. This happens because the space is smaller, so particles (moving at the same speed) collide more frequently with the surfaces.

1. Investigation 1: Balloon demonstrates that gases have weight and make the ball firmer and larger.

2. Investigation 2: Syringe demonstrates that gases can be compressed/squeezed and that this process raises the pressure. Students often think that gases like air are continuous or wavy (not made of particles). By compressing the syringe and hearing the gases escape after compression, students are challenged to accept that gases are made of particles. The particles move closer together as the syringe compresses the gases.

Connecting Investigations 1 and 2 to the landfill bottle: The idea of particles as moving freely in available space helps students understand that in the open system landfill bottles, smell particles can escape from the bottles and move across the room. Note that the smell is spread around through the process of random collisions (diffusion) and the process of a flow of air (air currents/wind) in the room. The second process is much faster at spreading the smell from one side of the room to the other.

Introducing the Lesson

Making Observations of the Smell Coming from Landfill Bottles to Introduce New Sub-Question, *What is That Smell?*

Review the observations, *When we made observations of properties of the materials in our landfill bottles, we observed an odor or smell and added questions about smell to the DQ Board.*

Point to the questions added to the DQ Board from last class. Read some of the questions added to the DQ Board last class. Say, *Since many of our questions about smell are related, let's ask, What is that smell*?

Prompt students to think about the smell from the landfill bottles.

Teacher suggested prompts:
- *Who noticed the smell from the landfill bottle first?*
- *Who can smell the landfill bottle now?*
- *Does the distance from the landfill bottle to our noses make a difference in how strong the smell is?*
- *Why can I smell pizza in the lunch room from the hallway?*

To answer our question, What is that smell?, first, we will figure out if smell is something or nothing. Let's investigate further.

Carrying Out the Lesson

Connecting Prior Conceptions about Smell to Gas

Make a connection between the smell from the landfill bottle and many other smells the students have encountered. Ask students to give examples (lunch food, chocolate, candy, chewing gum, home garbage, spoiled milk, onions).

Hold up the container of scented material and tell students that they should raise their hands when they smell the scent. This demonstration can be done from the front of the room or from the center of the room. Open the container. After the smell has traveled across most of the room, ask students what would make the smell reach the back of the room faster (waving our hands, a fan, an open window). Some students may say a fan. Take out the small hand-held fan or ask a student volunteer to hold the fan over the container of scented material. Continue the discussion about the smell and whether the smell is something or nothing.[1]

Ask, *How do you notice the scent?* (You smell it with your nose. The scent travels to your nose. You breathe the smell into your nose. Your eyes get runny.)

SEN Entry: Developing Individual Models: Gases

Tell students they will develop a model that shows their initial ideas about the smell and the air, *As scientists we use our best current model to ask the questions we need to investigate to find out more. As we investigate we will compare our models to the evidence from our investigation and revise them as needed until they fit with all the evidence. So far we have developed models of matter for particles of solids and liquids.*

CLASS CHECK! Modeling Solids and Liquids as Particles Follow-Up

Say, *Last class we developed models of solids and liquids.* Review particle nature of solid and liquid matter, as needed, based on students' models of solids and liquids in Lesson 2-3.

Now we are going to think about gases such as air, or the smelly gas coming from the garbage. At this point, do not tell students that gases are also made of particles.

Ask students to imagine they have a tool like a very powerful microscope so they could see the gases up close. *Now we are going to try to make a model for gases – a diagram that shows what we would see if we had such a tool. Since we cannot see many gases, we know that we could only see the gases at a scale that is very, very small – too small to see with our eye. What would that enlargement look like?*

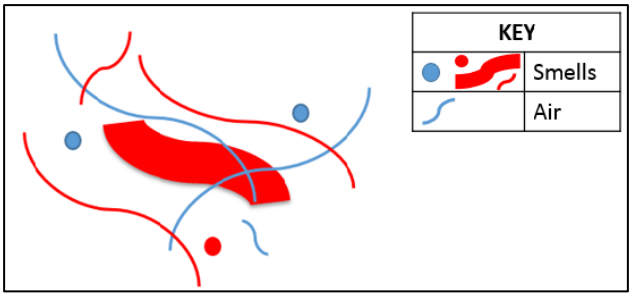
[1] Inspired by IQWST 2013 SASC LLC

Direct students to draw their individual models in their SEN of what gases might look like when enlarged. Remind students to include a title and the date, label parts of their models, and use a key for the symbols in their models. Remind students that someone should be able to "read" their models.

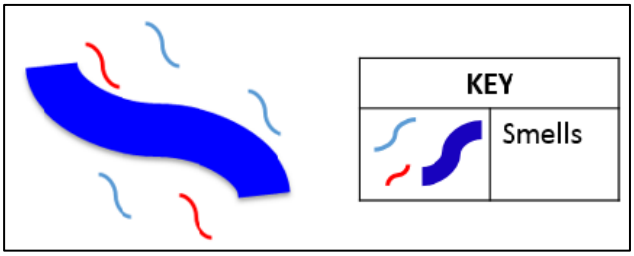
Once the models are complete, allow time for students to describe their models to a partner.

Possible Student Examples:

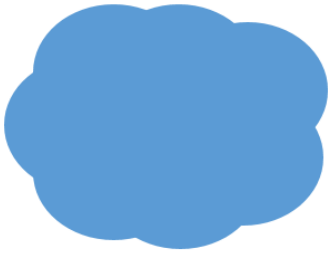
Possible Example 1



Possible Example 2



Possible Example 3



Say, *The model represents your current thinking about gases. Your thinking may change as we continue our investigations and find additional evidence about smell and other gases. I see that many of you included matter particles in your models.*

Teacher Background: Developing Initial Models of Gases

This is the first of several models in the lesson, which will eventually be incorporated into the class consensus model of landfill bottle systems. Because they have modeled solids and liquids as particles, some student models will probably contain particles, but they may also

contain other features, such as wavy lines for wind or waves that represent some kind of support structure holding up the particles.

The idea that gases are made up of particles too small to see is a difficult conceptual idea. The CCC of this lesson is Scale, Proportion, and Quantity, which students have not had exposure to in the K-2 grade band. As students are developing their initial models, you may guide students to think about what the wavy lines or clouds would look like if students could "zoom in" on them. By guiding students to "zoom in" on a gas, students are progressing to the Middle School expectation for the Scale, Proportion, and Quantity CCC, *Phenomena that can be observed at one scale may not be observable at another scale.*

Asking the Question, *Are Gases Something or Nothing?*

Your models describe, What are gases? Let's think about whether air is something or nothing.

To draw the students' attention to the idea that the smell is something that comes from a source and goes into the nose, but we can't see it:

- Ask students to breathe deeply, hold their breath for a moment, and then blow it out as hard and fast as they can. Then ask, *What did it feel like as you held your breath*? (pressure, bursting feeling) *What did you feel moving into and out of your lungs?* (air, oxygen, gas)
- Tell the students that there is agreement that we can feel air going into our body, and we can feel the air pressure as we hold our breath. *Air is something because we can feel it.*

Next class we will carry out 2 investigations to learn more about air.

Break – end of class period 1

Resume during the next class period:

Reconnect to the Sub-Question, *What is That Smell?*
Describe the plan for the class period, *We are going to observe and investigate air to collect more data to answer our question, What is that smell? We will use these data to refine our models from last class.* *We will complete 2 investigations, one using a balloon and another using a syringe. For each investigation, think about how the data matches your ideas about What is that smell?*
Making Observations of Air in Investigation 1: Balloon
Tell the class, *For our first investigation we are going to observe air in a balloon. As you watch the video, think about your models of smell and air.* Show Video Lesson 3-2: Balloon. Ask if the data surprised anyone. Guide student thinking: • *What was in the balloon?* (Air.) • *What changed when the balloon was punctured?* (Air left the balloon.) • *What does this tell us about air?* (Air is something. Air moves. Air has weight. Air is matter.) • *What evidence do we have that air has weight?* (We saw in the video that there was a weight difference when the air left the balloon. Once the balloon was punctured, she couldn't rebalance the scale.) Remind the students how we have previously used matter as a general term that includes solids and liquids, is anything that has weight, and is made up of particles that are too small to see. *Now that we have observed that air also has weight, what does that tell us about air?* (Air is matter. Air is a gas. Air is made of particles.) *Think about how the data in the investigation matches your ideas about What is that smell?* Say, *As we make more observations of air, let's keep this idea that air is matter, has weight, and is made of gases.*
Making Observations of Air in Investigation 2: Syringe
Describe the investigation plan, *We are going to do another investigation to help us explain what air, as a gas, is made of. Think about how the data from this investigation matches your ideas about What is that smell?*

Introduce the equipment for the next investigation. Tell students that they will investigate using a syringe. Hold up a syringe and name the moveable part as the plunger.

Tell the students to use the lowest mark on the plunger as the stopping point of the measurement. Describe the milliliter marks as increments of ____ mL. Pull out the plunger and describe how to cover the open end. Do not push the plunger.

Pass out 1 syringe per group. Have the students practice moving the plunger to different increments. Allow time for each student to have a turn.

Pass out Investigation 3-2: Gases. Guide students through the procedures. Then, give time for students to complete the investigation in groups.

SMALL GROUP CHECK! Gases

As students work, circulate among groups.

Possible prompts to guide student thinking:

- *When you push down the plunger, you feel the pressure of the air pushing back on the plunger. What does this tell you about air?* (Air is something. We can feel it.)
- *Why can't you push the plunger all the way down?* (Air is inside.)
- *How does this show you that air is something?* (If air were nothing, the plunger would go all the way down.)
- *What did you feel when you released the plunger?* (Air was escaping the syringe.)
- *What did you figure out about air when you released the plunger?* (Air is something. We can feel it.)

After all groups complete the investigation, tell the students, *We have a lot to think about.*

Tell the students that they have figured out an important scientific idea about gases, and guide students to make sense of their observations. Say, *You figured out that gas is something. When you pressed down on the syringe, you felt something pushing back. What you felt pushing back was actually gas particles.*

Remind students about their models for solid and liquid matter as being made up of particles too small to see. *In solids and liquids, the particles are bunched together so we see the collection of them, even if we cannot see the individual particles.*

Call on students to share how Investigation: Balloon and Investigation: Syringe support the idea that gases are made of particles.

Next class we will use the data from our investigations as evidence to help us revise our models for gases. This can help us answer the questions we asked, What is that smell? and, Are gases something?

Break – end of class period 2

Resume during the next class period:

Obtaining Information from a Computer Simulation

Ask, *What evidence do we have that helps us to explain what air is made of? Let's think about the balloon and syringe investigations.* Review and discuss the investigations.

Possible student responses:

- Investigation 1: Balloon
  - Air has weight.
  - Matter is anything that has weight.
  - Air is matter made of particles too small to see.
- Investigation 2: Syringe
  - Air is something.
  - Air is made of particles too small to see.
  - The air particles move freely.

Tell students, *The syringe investigation helped us to understand that air is something and made of particles too small to see. Let's broaden our thinking to any gas. We can visualize air particles or other gas particles moving freely using another kind of model. This model is a computer model, also called a computer simulation.*

Display the computer simulation with the particles in gas form:

- Visit the website: https://phet.colorado.edu/sims/html/states-of-matter/latest/states-of-matter_en.html
- Select "Phase Changes" simulation.
- Use the pump on the left to add air into the chamber until the chamber is half-full of particles.
- Click and drag the finger down. Make observations of the speed of the particles, the direction of the particles, and the change in pressure (pressure gauge).
- Challenge students to choose one particle and follow its path.

Ask, *How does this computer simulation model help you to understand what happened in the syringe investigation? Share your answer with your partner.*

Call on a few students to share what their partners said.

Summarize, *When you push down the plunger, you feel pressure. That pressure comes from the particles bouncing off the surface of the plunger. In the smaller space, the particles bounce more, so you feel more pressure.*

Revising Individual Models of Air and Gas

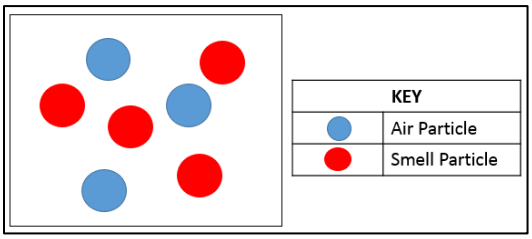
Remind students that their initial models represented their ideas before the investigations.

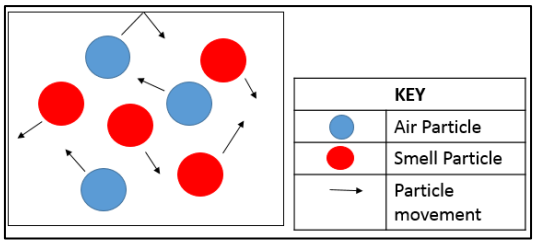
Describe, *What have we figured out so far? Air is something because it has weight. Air is made of particles that move around in space because we can feel it. Other gases also are made of particles that move around in space. Now with this model for gas, let's see if we can answer the questions we had about smell. What is that smell? Is smell something or nothing? Using our model as a thinking tool, can we explain how a smell travels across the room?*

Direct students to:

- Open SEN to their individual Model: Gases from Day 1.
- Talk in groups about what they might change or add to their models.
- Develop a revised model individually in Model: Gases (revised) and write a few sentences to describe, based on their model, how the smell gases get from their source to a student's nose across the room.

Possible Revised Student Models:





CLASS CHECK! Modeling Gases as Particles

Collect Model: Gases (revised) and check the extent to which students' individual models represent the particle nature of air and gas (e.g., use dots with arrows). Many of the models typically include matter particles plus something else to represent the air. Do not pressure students to drop "wrong" features. Instead, accept a range of models at this stage. You will review particle nature of air and gas when students represent gases leaving the landfill bottle system in their models at time point 3.

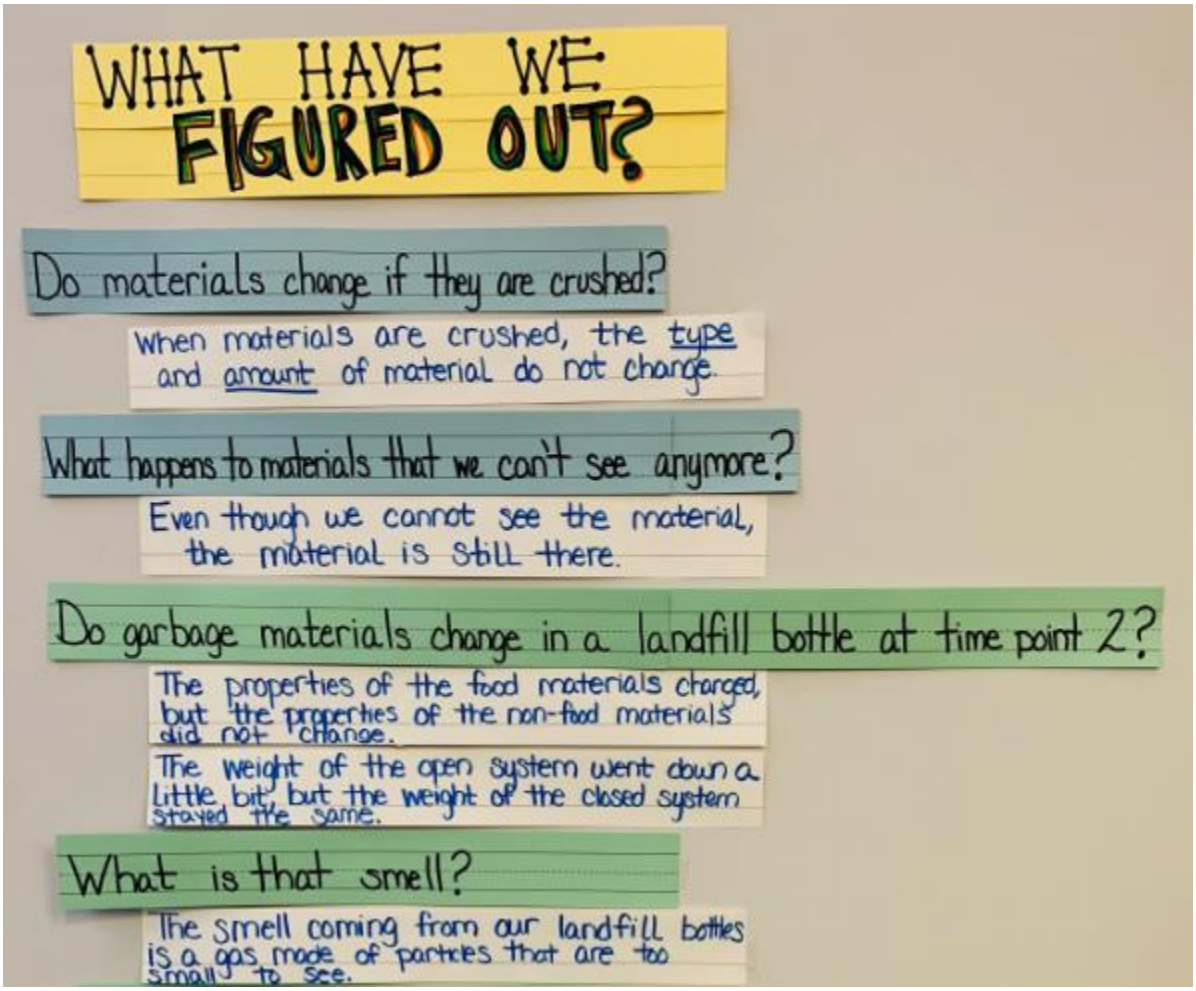
Closing the Lesson

Connecting to Next Question

Describe the next step to the students, *Next we will check the materials in the landfill bottle system and what has happened to their properties and weight.*

Tracking What We Figured Out (optional)

Guide students to think about the sub-question of the lesson and what they have figured out so far. Create the class visual display using their responses. In addition to the class visual display, students may complete the individual graphic organizers (located in Lesson 2-2). Students can add to their graphic organizers after each lesson.



Evidence Statements Lesson 3-2

LP3-2. ES

- Students develop Model: Air and Smell as made up of particles that are too small to see and move freely. Students use the model to describe how smell from the landfill bottle travels across the room when gas/air particles move freely.

LP3-2. ES

- Students observe weighed objects with and without air to produce data, which serves as evidence that air has weight and is something, i.e., matter.

Connections to Targeted 5th Grade NGSS Performance Expectations

5-PS1-1 Develop a model to describe that matter is made of particles too small to see.

Building Progressions

SEP *Planning and carrying out an investigation*: *Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.*

K-2: Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question.

3-5: *Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.*

Middle School: Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.

SEP *Using mathematical and computational thinking*: *Describe, measure, estimate, and/or graph quantities such as area, volume, weight, and time to address scientific and engineering questions and problems.*

K-2: N/A

3-5: *Describe, measure, estimate, and/or graph quantities such as area, volume, weight, and time to address scientific and engineering questions and problems.*

Middle School: Use mathematical representations to describe and/or support scientific conclusions and design solutions.

SEP *Developing a model*: *Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution.*

K-2: Develop a simple model based on evidence to represent a proposed object or tool.

3-5: *Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution.*

Middle School: Develop a model to describe unobservable mechanisms. Develop a model to describe phenomena.

DCI *PS1.A*: *Matter of any type can be subdivided into particles that are too small to see, but even then, the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects.*

K-2: Different kinds of matter exist and many of them can be either solid or liquid, depending on the temperature. Matter can be described and classified by its observable properties. Different properties are suited to different purposes. A great variety of objects can be built up from a small set of pieces.

3-5: *Matter of any type can be subdivided into particles that are too small to see, but even then, the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects.*

Middle School: Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.

CCC *Scale, proportion, and quantity*: *Natural objects exist from the very small to the immensely large.*

K-2: N/A

3-5: *Natural objects exist from the very small to the immensely large.*

Middle School: Phenomena that can be observed at one scale may not be observable at another scale.

Connections to CCSS for English Language Arts-Literacy

W.5.2: Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

W.5.2.E: Provide a concluding statement or section related to the information or explanation presented.

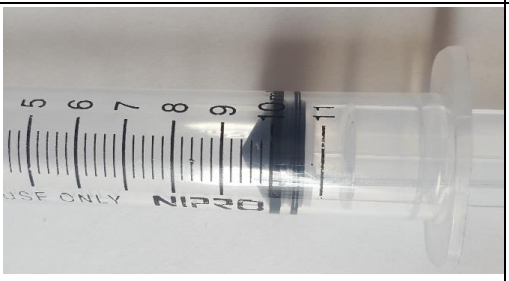
SL.5.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher- led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly.

SL.5.1.C: Pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others.

L.5.6: Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases, including those that signal contrast, addition, and other logical relationships (e.g., however, although, nevertheless, similarly, moreover, in addition).

Name _____ Date _____

Investigation 3-2: Gases

Investigation plan		✓
1	Gather materials: ☐ 1 Syringe (any size, approx. 10 mL)	
2	Raise the plunger to 10 mL. Record the volume in the investigation table. ☐ Use the lowest mark on the plunger as the stopping point of the measurement. 	
3	Use your palm to tightly block the syringe opening. Press the plunger down as far as you can. Record the volume in the investigation table. 	
4	Remove your palm from the syringe opening, while pushing down the plunger. Observe what happens. 	

Investigation Table:

Condition	Volume (mL)
Initial volume (raised plunger)	
Final volume (pressed plunger)	

Observations:

What do I see? 	
What do I feel? 	
What do I hear? 	

Investigation Questions:

1. What is in the syringe?

_____

_____

2. Why can't you push the plunger all the way down?

_____

_____

_____

_____

3. What do you feel when you release the plunger?

_____

_____

_____

_____

4. What did you figure out from the syringe investigation?

_____

_____

_____

_____

Name _____ Date _____

Model: Gases (revised)

Investigation 3-2 ANSWER KEY

Investigation Questions:

1. What is in the syringe?
   Air

2. Why can't you push the plunger all the way down?
   Air is inside. Air is something.

3. What do you feel when you release the plunger?
   Air particles are escaping the syringe.

4. What did you figure out from the syringe investigation?
   I can feel air coming out of the plunger, so I know there is something inside of the syringe. That something is air.