LESSON 5

AIR ON THE MOVE

How does air move and change when a storm is forming?

ENGAGE · EXPLORE · EXPLAIN · ELABORATE

AT A GLANCE

ACTIVITY DESCRIPTION	MATERIALS
(100 minutes)	
Demonstration: Warm and Cool Air Students watch a demonstration of warming up and cooling down air inside a Mylar balloon that has been partially deflated. Students discuss what they think happens to cause the balloon to go up or down.	**Lesson 5: Student Activity Sheet** LESSON 5 Mylar balloon with helium Hair dryer
Interactive Reading: Air on the Move Students read about the warming of air and evaporation of water at the surface and how this air moves during convection. Students make illustrations of concepts throughout the reading and connect back to previous evidence they have collected.	Colored pencils
Consensus Model: Isolated Storm The class works together to construct a class Consensus Model for explaining the best atmospheric conditions for storms. Students pull together ideas from their previous Working Models to create a comprehensive model to show how moisture becomes available in a location, increasing the chance of an isolated storm.	Whiteboard, smart board, or chart paper and markers (for the Driving Question Board and Model Idea Tracker) Whiteboard or chart paper and markers (to make the Consensus Model)

LESSON 5

AIR ON THE MOVE

How does air move and change when a storm is forming?

NGSS Sensemaking

This series of activities will help students to piece together different parts of a model they've been working toward in previous lessons. The goal is for students to identify important underlying mechanisms and processes that explain how moisture becomes available over a location in an isolated storm. Students use evidence from their investigations to vet the emerging model against their Model Ideas, or the rules of the system.

PERFORMANCE OUTCOME

- Conduct an experiment and analyze and interpret data to describe how changes in temperature in a body of air cause the air to change and move.
- Develop and use a model to explain how energy from the Sun, convection, water on the surface and in the air, and variations in temperature and humidity create conditions/cause the formation of isolated storms.

NGSS DIMENSIONS (GRADES 6-8)

- Global movement of water and its changes are propelled by sunlight. Weather is influenced by interactions involving sunlight, the atmosphere, and land.
- Analyze and interpret data to provide evidence of a phenomenon.
- Collect data to produce data to serve as the basis of evidence to answer scientific questions.
- Develop and/or revise a model to show the relationship among variables including those that are not observable but predict observable phenomena.
- Cause and effect relationships may be used to predict phenomena in natural systems.

NGSS DIMENSIONS (GRADES 3-5) (REINFORCING)

- Collaboratively develop and/or revise a model based on evidence that shows the relationships among variables for frequent and regular occurring events.

Teacher Procedures

Demonstration: Warm and Cool Air

1. **Navigate from the previous lesson.** At the end of the previous lesson, students shared their ideas about how water at the surface (near the bottom) of their bottles got onto the upper parts of the bottles.

   Review this discussion using the following question prompts:

   - *What happened to the water at the surface before it traveled to the top of the bottle?*
   - *What happened to the water at the top of the bottle?*
   - *How did that water get up there? Why would it go up?*

2. **Motivate the need to investigate vertical movement of air.** Students may say evaporation is how water at the surface gets higher in the atmosphere. Remind students about the water cycle. Talk about what evaporation means and how it explains the change of liquid water to gas but not how it travels upward. (Consider whether students need additional support to understand processes of the water cycle.)

   Suggested transition:

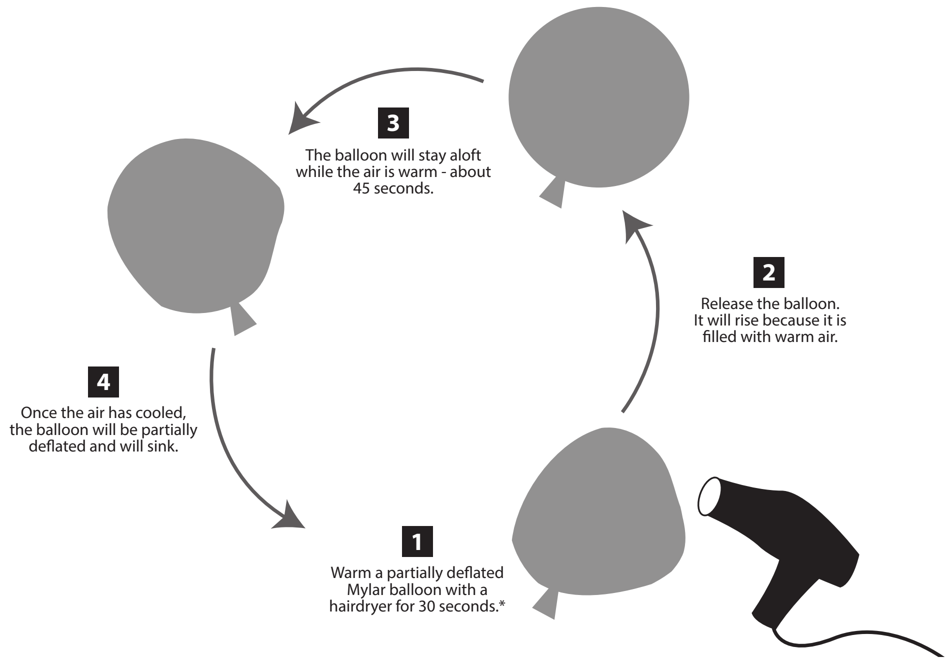
   - *"So we know the surface is warmed here and water evaporates, and we know water condenses up here because it's cooler, but how and why does the water vapor travel up? We need to figure this out. If we add heat to air down here, can we get the balloon to travel up?"*

3. **Elicit student experiences of warmed air and steam.** Ask students to think about why recently warmed water vapor would travel up. Broaden the discussion to elicit students' experiences of warmed water vapor (e.g., steam) and warmed air (e.g., "heat waves" off highways). Point out a pattern that this warm air seems to move up. Ask students why they think warm air moves upward.

4. **Introduce students to the Mylar balloon investigation.** The Mylar balloon contains helium gas, and students are going to heat the gas to see if they can get the balloon to move upward.

Storyline Link
This move establishes the need to explain air traveling upward. Students might think evaporation is sufficient. They need help seeing they are missing a piece to their models.

MYLAR BALLOON DEMONSTRATION



TIME:

- Set-up is less than a minute
- *The time it takes for the balloon to visibly inflate will vary (typically 20-60 seconds)
- The balloon will stay aloft for about 45 seconds before deflating and sinking back to the floor

MATERIALS:

- Partially deflated Mylar balloon filled with helium. Needs to be lightly rested near the floor
- Hair dryer
- Straw

TIPS AND ADVANCE PREP:

- Deflate the balloon by inserting a drinking straw three-quarters of the way into the hole near the base of the balloon. Lightly squeeze some air from the balloon but avoid emptying the balloon too much. Prepare a few extra balloons in case a one or more don't function properly.
- If you have an IR thermometer, consider taking temperature measurements of the balloon just before, as it's being heated, and as it cools.

VIRTUAL RESOURCES:

- Demonstration video: https://scied.ucar.edu/warming-mylar-balloon

LESSON 5
STEP 1

5. **Draw the lab set-up.** Direct students to *Lesson 5: Step 1* of their student activity sheets. Ask students to draw the demonstration set-up on their activity sheets.

6. **Warm the Mylar balloon.** Have a student volunteer to warm the Mylar balloon using a hair dryer. It is important to represent the balloon as a pocket of air located at the surface of Earth. The hair dryer should represent thermal energy radiated from the ground and not light energy from the Sun above.

LESSON 5 STEP 1

7. **Make observations of the balloon.** Students make observations of what they see and hear happening to the Mylar balloon as the air inside is warmed (e.g., crinkling as it expands and travels up to the ceiling). Prompt students to add these observations to their observation sheet in *Lesson 5: Step 1*. Continue observing the Mylar balloon as it cools (roughly one minute or less). Once the air inside the balloon cools, it begins to sink and visibly shrink. Prompt students to add observations to their observation sheets. Repeat the demonstration a second or third time with different student volunteers to make additional observations and to prompt students to start explaining what's happening in the balloon.

8. **Develop an initial explanation.** Direct students to the questions at the end of *Lesson 5: Step 1* on their activity sheets. Students are prompted to explain what is happening inside the Mylar balloon as it is heated and when the balloon sinks. If students are new to particle motion and thermal energy, they may be more uncertain about what's happening in the balloon. You are steering them toward a basic understanding that warmed air molecules move more and are more spread apart, and vice versa for air molecules that have cooled. Students will encounter these concepts in the reading that follows. Encourage students to think about the balloon having the same amount of air, whether warm or cool, but changing in terms of volume, which they see when the balloon expands and contracts.

Interactive Reading: Air on the Move

LESSON 5 STEP 2

1. **Navigate from the Mylar balloon investigation.** Students have initial ideas explaining the warm air inside the balloon traveling up. They likely need more information to put together the pieces of a convection model. Explain to students that reading more about the molecules in the air can help them figure out more of what's going on. Direct students to *Lesson: 5, Step 2*, an interactive reading called Air on the Move. Students will interact with the new information by drawing diagrams and summarizing new information.

2. **Read the first two paragraphs and diagram warm and cool air.** The first part of the reading focuses on what happens when heat transfers to air molecules or when those molecules lose energy. Students draw diagrams to show warmed air molecules in a balloon moving faster and spread apart and cooler air molecules closer together and moving slower.

3. **Read about how gravity affects air molecules.** Students read and draw air molecules low in the atmosphere at higher pressure and high at lower pressure (more spread out), which will help them understand why warm air rises. Have students label where "low pressure" and "high pressure" are on their drawings.

4. **Read about convection.** Students read and look at a particle diagram showing how air molecules change during convection. After reading, pose the question: "How could convection be related to _______?" (e.g., the Mylar balloon, the bottle models, storms forming). Students are reminded about the relationship between water vapor and warm/cooled air (from *Lesson 4*). The vapor condenses from the air when the air reaches cooler temperatures.

5. **Revisit explanations of warm air rising and add to the Model Idea Tracker.** Conclude the reading, reflecting on the question: "Why does warm air go up and cool air go down?" Students write their ideas on the reading first. As students share their thinking with the class, prompt students to connect to the previous phenomenon or data patterns they have seen in the unit (e.g., Mylar balloon, bottle models, isolated storm time-lapse videos, temperature patterns from the surface to the clouds), and how the new concepts help them explain what they observed.

   Model Ideas:

   - Warm air rises and cooler air sinks.
   - Warm air is able to take in more water vapor compared to cool air.

Literacy Connection
Students interact with this reading by making connections and synthesizing new information with what they have learned previously.

Obtaining Information
Students read scientific text to determine critical concepts that help them explain phenomena.

Storyline Link
This is a critical moment in the Explain lesson where students start to use particle motion, convection, and humidity to explain phenomena.

Developing & Using Models
Add to the Model Idea Tracker new ideas about convection and humidity obtained from the reading and Mylar balloon investigation.

Consensus Model for an Isolated Storm

1. **Devote time to "taking stock" by returning to the Driving Question Board.** As you navigate from the reading and students' recently developed ideas about air molecules, particle motion, and convection, have students reflect on what they have learned. Return to the Driving Question Board to see which questions students can now answer. As students review their questions and develop answers to some of those questions, use this information to inform how you approach the Consensus Model. It might be the case that students need to revisit a particular data set from earlier in the sequence to "refresh" their thinking and/or to make connections they have not made yet.

2. **Revisit the stormy day time-lapse video to motivate explanation of this phenomenon.** Replay the isolated storm time-lapse video, and have students work in small groups to discuss important things happening for the storm to form. Tell students they are going to develop a model to explain the isolated storm:

   - *"Let's see if we can put together all the things we've learned to create a model that explains what's happening for the storm to form."*

3. **Revisit the Model Idea Tracker.** Use the Model Idea Tracker to review important "rules of the system". These Model Ideas have evidence to support them and can help students make sense of how a system works. As students construct the Consensus Model for an Isolated Storm, they should pay attention that it is consistent with their Model Ideas.

LESSON 5 STEP 3

4. **Prepare for the Consensus Model.** Direct students to *Lesson 5: Step 3* on their student activity sheets to record their ideas individually about how precipitation happens in an isolated storm. Tell students that after they develop their model, the class will construct a Consensus Model for an Isolated Storm that takes student model ideas into account.

5. **Develop a Consensus Model.** In a public space, draw the Consensus Model for an Isolated Storm as students share their thinking about important processes and conditions for storms. For each suggested addition, put the idea forth to the class for other students to clarify and add to before it is recorded on the class model. Specifically ask students to cite data or other evidence to support their ideas. A list of guiding questions is provided on the student activity sheet to help organize parts of the model.

6. **Record the Consensus Model.** After the class version of the Consensus Model for an Isolated Storm is complete, direct students to revise their models on their student activity sheets using a different color of pencil. Encourage students to represent their thinking in different ways if it helps them make sense of what's happening in the model. They do not need to record the exact model constructed by the class, but they do need to record one that is consistent with the Model Idea Tracker.

Assessment
Returning to the Driving Question Board allows for you and your students to assess the progress on their questions. You can formalize this assessment as much as you prefer, for example, asking students to write explanations to their questions or simply discuss their new ideas aloud.

Developing & Using Models
Students develop a model to explain an isolated storm phenomenon. The model is vetted against their evidence.

Name Period Date

LESSON 5

How does air move and change when a storm is forming?

Your teacher will demonstrate how air changes as it is heated or cooled. This will help you figure out what happens to air that warms near the surface, and air that cools at higher altitudes.

STEP 1: Observe warmed and cooled air.

Draw the lab set-up and what happens to the balloon during the demonstration. Add your observations to your drawing as you make them. Remember to label what is happening.

LAB SET-UP	MYLAR BALLOON BEING HEATED	MYLAR BALLOON AS IT COOLS

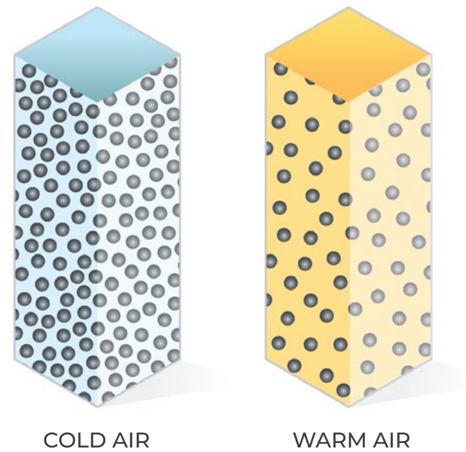
1. Why does the heated balloon go up? Think about what is happening inside the balloon.

2. What is happening inside the balloon when the balloon starts to sink?

How does air move and change when a storm is forming?

STEP 2: Air on the Move

There is something different between warm and cool air that causes warm air to go up and cool air to go down. When the air inside the balloon was warmed, the balloon expanded and went up. When the air inside the balloon cooled, the balloon started to shrink and go down. Let's think a little more about this air and what is happening when it is warmed and cooled. To understand this, we are going to need to zoom in and think about what's happening to the air molecules.



Imagine you can see a pocket of air molecules heated up. When air is heated, the heat energy is absorbed by the individual molecules, causing them to move around more quickly. The molecules move faster and farther apart. When molecules release their energy, they start to slow down and cluster closer together. This happens when the molecules no longer have a heat source and are "cooling."

Draw a diagram that shows what 20 warmed air molecules look like inside the mylar balloon compared to 20 cooler air molecules.

BALLOON WITH WARM AIR	BALLOON WITH COOL AIR

So, that's how warm air and cool air are different. But why do they move in different directions? To understand that, we're going to need to zoom out and think about the whole planet and gravity.

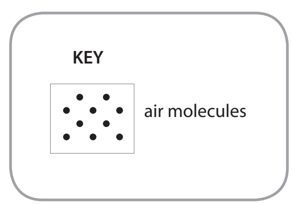
LESSON 5

How does air move and change when a storm is forming?

STEP 2 CONTINUED: Air on the Move

Gravity is the force that draws all objects towards the center of the planet. Even tiny things like air molecules are affected by gravity and pulled downward. The weight of the air molecules higher in the atmosphere pushes air molecules lower in the atmosphere closer together. High in the atmosphere, they are spaced father apart. Air molecules pushed close together are at high pressure. Air molecules spread apart are at low pressure.

Draw air molecules between the planet and the top of the atmosphere. Remember that they will be spaced differently depending on whether they are close to the ground or higher in the atmosphere.



How does air move and change when a storm is forming?

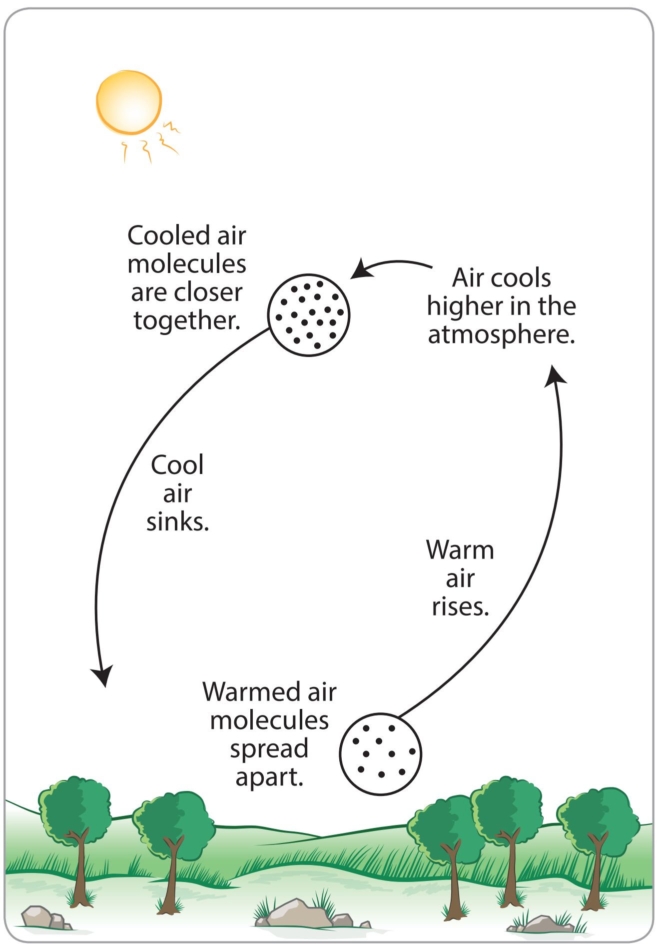
STEP 2 CONTINUED: Air on the Move

When sunlight warms the land, and then warms the air near it, the molecules spread out a bit, taking up more space, just like the air at high altitude. The warmed air has lower pressure than the air around it, so it rises in the atmosphere, like the warmed balloon in the previous activity.

As the warmed air rises in the atmosphere, it cools down, because air at higher altitudes is cooler. Remember that cool air doesn't hold as much water vapor as warm air, so as warm air cools, some of the water vapor condenses into the tiny water droplets that make up clouds.

As air gets cooler, the molecules come closer together. The air has higher pressure than the air around it, so it sinks in the atmosphere, like the cooled balloon in the previous activity. Then, it can be warmed and rise again.

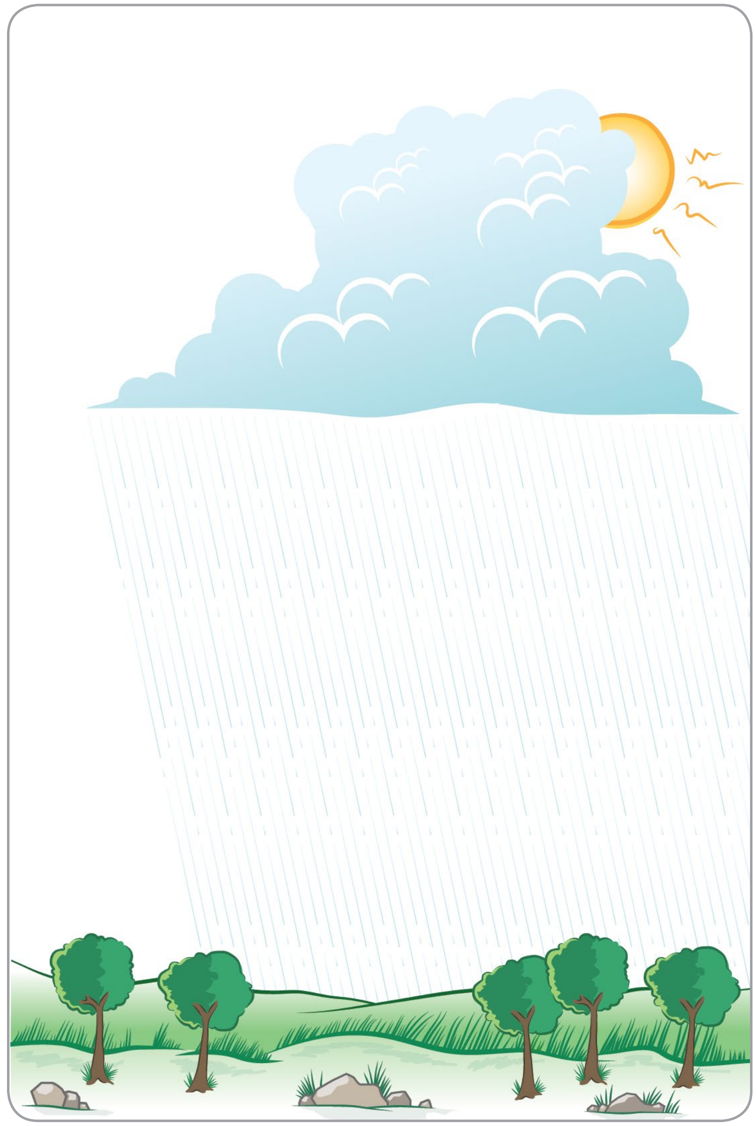
This cycle of rising and falling air is called **convection.**



EXPLAIN: Why does warm air go up and cool air go down?

How does air move and change when a storm is forming?

STEP 3: Create a model to describe how precipitation happens in an isolated storm.



To get started, **draw and write** in the illustration to explain how precipitation happens in an isolated storm.

Make sure your model explains:

- What happens to energy from the Sun that leads to an isolated storm?
- What happens to water at the surface and clouds that lead to the isolated storm?
- How does air temperature and humidity change as air moves from the ground to the cloud?
- How does air move between the ground and where the storm forms?

Write an explanation that goes with your model and answer the question below:

EXPLAIN: What has to happen for an isolated storm to form?