Lesson 1.3
Investigating Condensation
Simulating Condensation

Before setting up your tests, make a prediction about what you think will happen.

I predict there will be more condensation in the test that represents the air parcel (check one)

☐ at room temperature.
☐ in the cooler.

I predict more energy will transfer in the test that represents the air parcel (check one)

☐ at room temperature.
☐ in the cooler.

Why and when does condensation happen?

1. Launch the Weather Patterns Sim in Lab Mode.
2. With your partner, build Test 1 in the Sim.
3. Run the Simulation and observe what happens in the parcel.
4. Analyze your results. Record data in the table on the next page.
5. Repeat steps 2–4 for Test 2.
6. Answer the questions on the next page.

**Test 1:** This test represents the air parcel at room temperature.

- Surrounding Air Temperature: 20ºC
- Air Parcel Temperature: 37ºC
- Air Parcel Water Vapor: between medium and high

**Test 2:** This test represents the air parcel in the cooler.

- Surrounding Air Temperature: 4ºC
- Air Parcel Temperature: 37ºC
- Air Parcel Water Vapor: between medium and high
Simulating Condensation (continued)

<table>
<thead>
<tr>
<th>Test</th>
<th>Surrounding air temperature</th>
<th>Air temperature in the bag</th>
<th>Energy transferred out</th>
<th>Liquid water (cloud)</th>
<th>Liquid water (rain)</th>
<th>Total liquid water (cloud + rain)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test 1</td>
<td>20°C (room temperature)</td>
<td>37°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test 2</td>
<td>4°C (in the cooler)</td>
<td>37°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Which test had more condensation (water vapor turning to liquid)? (check one)

- [ ] Test 1 (room temperature)
- [ ] Test 2 (cooler)

In which test was there more energy transferred out? (check one)

- [ ] Test 1 (room temperature)
- [ ] Test 2 (cooler)

Think about the different factors in the two tests. What do you think caused one to have more condensation?

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___________________________________________________________________________________________
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Homework: Reading “What Makes Water Move?”

Read and annotate the “What Makes Water Move?” article. Then, answer the questions below.

What does gravity do to cause rain to happen?
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___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________

How does gravity affect water that is on the surface of Earth?
___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________

Active Reading Guidelines

1. Think carefully about what you read. Pay attention to your own understanding.
2. As you read, annotate the text to make a record of your thinking. Highlight challenging words and add notes to record questions and make connections to your own experience.
3. Examine all visual representations carefully. Consider how they go together with the text.
4. After you read, discuss what you have read with others to help you better understand the text.
What Are Clouds?

Looking Up at the Sky

Dr. Joanne Simpson became fascinated with clouds at an early age. Simpson would grow up to study clouds and become the first woman to earn a PhD in meteorology—but as a child, she simply loved how they looked. When she was a young girl, walking around her town and sailing on the nearby ocean, she noticed all kinds of unusual clouds. She saw clouds that looked like towers looming high, bunches of hanging grapes, and even UFOs! She wondered what they were made of and how they formed so many different amazing shapes.

When Simpson went to college in the 1940s, nobody thought clouds were important for scientists to study. However, Simpson’s professors encouraged her to study clouds because she was a woman and they didn’t think women could be serious scientists. Clouds seemed to them like a good unimportant subject for a woman to study. Simpson went on to prove her professors wrong about both clouds and female scientists.

Determined to succeed despite sexism, Simpson continued her study of clouds and cloud formation. She collected data as she flew in airplanes high above Earth’s surface, taking notes and sketching in her field journal to document the cloud formations she saw. Most interesting of all to Simpson were the gigantic clouds she called hot towers. These cumulonimbus clouds looked like
skyscrapers sticking up above the clouds around them. Simpson wanted to know why hot towers were so unusual, so she set out to study them. She collected data about the temperature, wind conditions, and amount of water vapor in these unusual cloud formations. Eventually, she was able to explain that hot tower clouds form when warm air with lots of water vapor in it rises quickly from Earth’s surface into the troposphere, the layer of the atmosphere closest to the Earth, cooling as it goes. Based on her research about hot towers and other kinds of clouds, Simpson is considered one of the most important weather scientists in the history of meteorology.

**What All Clouds Share**

Research by meteorologists like Simpson shows that all clouds, even the most unusual types, have a lot in common. Meteorologists use a helpful concept, the idea of air parcels, to study all kinds of clouds and track them as they move through the troposphere. An air parcel is an amount of air that moves as a unit.

All clouds form when the water vapor in air parcels comes into contact with colder surrounding air. When it meets the colder air, the water vapor in each air parcel becomes liquid in a process called condensation. In fact, all clouds are made of the same basic ingredient: visible droplets of water floating in the troposphere. If it’s cold enough, the water droplets can freeze into tiny ice crystals. How does water vapor get into the troposphere in the first place? It comes from liquid water on Earth’s surface. When liquid water gets warm enough, it turns into water vapor through a process called evaporation. The water vapor becomes part of the air and is ready to become part of a cloud when the conditions are right.
Cloud Formation and Energy

Cooling is an important cause of rainfall—cooling air parcels can cause clouds to form and rain to fall. What causes an air parcel to cool? The process is driven by energy. When a warm air parcel is surrounded by colder air, the energy from the warm air parcel is transferred to the colder air until the temperature of all the air is equal. While an air parcel is losing energy, the temperature of the air parcel decreases. The energy transfer that causes the warm air parcel to cool can also cause the water vapor in the parcel to condense into liquid water. This liquid water is what forms a cloud. The more energy the air parcel loses, the more it cools and the more liquid water it forms, making more rainfall possible. When the droplets of liquid water in the clouds become big enough, they fall to the ground as rain.

Joanne Simpson’s Legacy

Joanne Simpson started her career focused on the beautiful shapes she saw in the sky, wondering how and why the amazing clouds that she saw might form. Simpson’s curiosity as a child led her to a pioneering career in the field of meteorology. Her work helped us understand how energy, evaporation, and condensation form the clouds that we see in the sky. Meteorologists today still make use of Simpson’s work as they study the weather.
This diagram shows how energy is transferred during cloud formation. As energy is transferred out of an air parcel, its temperature drops. When the air parcel has lost enough energy and become cold enough, water vapor in the parcel condenses, forming a cloud.
Why Don’t All Clouds Produce Rain?

For precipitation to form and fall, there must be clouds—precipitation never falls from a clear blue sky. However, not all clouds produce precipitation. You probably see clouds every day, but you probably don’t experience rain every day. Why do some clouds produce precipitation and others don’t?

Clouds produce rain when tiny droplets of liquid water begin to stick together, forming larger and larger drops. When those drops get heavy enough, they fall as rain. However, the conditions have to be right for those processes to take place. If a particular cloud doesn’t have the right conditions, it won’t produce any rain. For example, if there aren’t enough droplets of water in a cloud to collide and form large drops, the tiny droplets will stay suspended in the air and it won’t rain. In some very hot and dry places, rain may start to fall from a cloud but the drops evaporate while they are still high in the air. Thin, wispy clouds are usually made up of tiny ice crystals, and the ice crystals are spread too far apart to collide and form snowflakes. These are just a few of the factors that can keep the water droplets in clouds from turning into precipitation that falls to the ground.
What Makes Water Move?

Water is always on the move. In fact, water on Earth goes around and around in a cycle with no beginning and no end. This endless cycle is driven by many factors, including energy from sunlight and the force of gravity.

The water cycle doesn’t really begin anywhere, but let’s start by thinking of water in the soil. A process called transpiration moves water upward out of the soil. Through transpiration, plants suck up water from the soil with their roots. The water moves through a system of tubes inside the plants, from the roots upward into trunks, stems, branches, and leaves. The tallest trees carry water upward more than 100 meters (about 300 feet)! After it reaches the leaves, the water evaporates into the air.

Evaporation moves water from Earth’s surface into the atmosphere, and this part of the water cycle is powered by the sun. Energy from sunlight causes liquid water to evaporate from the leaves of plants, from bodies of water, and from Earth’s surface, changing into a gas called water vapor. The water vapor moves upward into the atmosphere.

Gravity powers the next part of the water cycle. Water vapor high in the atmosphere condenses to form the droplets of liquid water that make up clouds. Earth is always pulling those droplets downward with the force of gravity, even when they are very tiny. However, the droplets are so small that the effect of that force isn’t very strong and the droplets stay suspended in the air. It isn’t until the droplets begin to stick together and gain more mass that the force of gravity on them is strong enough to make drops of water actually fall to the ground. These falling drops of water are known as precipitation.
The role of gravity in how and where water travels doesn’t end when water leaves the clouds. When water hits the ground, some of it sinks right in. That’s an effect of gravity—Earth is pulling the water down, forcing it between the particles of dirt and rock that make up the outer layer of Earth.

When the dirt and rock are full of water and can’t hold any more, the water stops sinking in and begins to flow over the surface. Again, gravity comes in. Earth pulls the water downward with the force of gravity, so the water always flows downhill. All of the water flowing downhill tends to gather in certain low-lying areas and keep on flowing—that’s how rivers form. All rivers flow downhill, sometimes for thousands of miles, until they reach the ocean. From the clouds to the ocean, gravity keeps water moving downward. Then transpiration and evaporation move it upward again, and the cycle continues on and on.
Simular condensación

Antes de configurar tus pruebas, haz una predicción acerca de lo que piensas que sucederá.

Yo predigo que habrá más condensación en la prueba que representa la parcela de aire (marca una)

☐ a temperatura ambiente.
☐ en la hielera.

Yo predigo que más energía se transferirá en la prueba que representa la parcela de aire (marca una)

☐ a temperatura ambiente.
☐ en la hielera.

¿Por qué y dónde sucede la condensación?

1. Inicia la Simulación Patrones de condiciones atmosféricas en modo “Lab” (Laboratorio).
2. Con tu compañero/a, construye la Prueba 1 en la Simulación.
3. Inicia la Simulación y observa qué sucede en la parcela.
5. Repite los pasos 2 a 4 para la Prueba 2.
6. Contesta las preguntas en la próxima página.

**Prueba 1:** Esta prueba representa la parcela de aire a temperatura ambiente.
- Temperatura del aire alrededor: 20°C
- Temperatura de la parcela de aire: 37°C
- Vapor de agua en la parcela de aire: entre mediano y alto

**Prueba 2:** Esta prueba representa la parcela de aire en la hielera.
- Temperatura del aire alrededor: 4°C
- Temperatura de la parcela de aire: 37°C
- Vapor de agua en la parcela de aire: entre mediano y alto
Simular condensación (continuación)

<table>
<thead>
<tr>
<th>Prueba</th>
<th>Temperatura del aire alrededor</th>
<th>Temperatura del aire en la bolsa</th>
<th>Energía transferida hacia fuera</th>
<th>Agua líquida (nube)</th>
<th>Agua líquida (lluvia)</th>
<th>Agua líquida total (nube + lluvia)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prueba 1</td>
<td>20°C (temperatura ambiente)</td>
<td>37°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prueba 2</td>
<td>4°C (en la hielera)</td>
<td>37°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¿Cuál prueba tuvo más condensación (vapor de agua convirtiéndose en líquido)? (marca una)

☐ Prueba 1 (temperatura ambiente)
☐ Prueba 2 (hielera)

¿En cuál prueba hubo más energía transferida hacia fuera? (marca una)

☐ Prueba 1 (temperatura ambiente)
☐ Prueba 2 (hielera)

Piensa en los diferentes factores en las dos pruebas. ¿Qué piensas que causó que una tuviera más condensación?

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___________________________________________________________________________________________
___________________________________________________________________________________________
Tarea: leer “¿Qué hace que el agua se mueva?”

Lee y añade apuntes al artículo “¿Qué hace que el agua se mueva?”. Luego, contesta las siguientes preguntas.

¿Qué es lo que la gravedad hace para causar que llueva?

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¿Cómo es que la gravedad afecta el agua que está en la superficie de la Tierra?

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Pautas de la Lectura Activa

1. Piensa cuidadosamente sobre lo que lees. Presta atención a tu propia comprensión.

2. Mientras lees, añade apuntes al texto para tener un registro de tus ideas. Destaca las palabras difíciles, y agrega notas para apuntar tus preguntas y hacer conexiones con tu propia experiencia.

3. Examina cuidadosamente todas las representaciones visuales. Considera cómo se relacionan con el texto.

4. Después de leer, discute lo que leíste con otros/as estudiantes para ayudarte a comprender mejor el texto.