

Dew Drops

Section THE CHEMISTRY OF LIFE & EARTH SCIENCES

Estimated Time ⌚ Setup: 5-10 minutes; Procedure: 15-20 minutes

OVERVIEW

Make condensation appear both on the inside and outside of a glass.

In this activity, students fill a jar first with hot water, then cold water. Depending on the temperature of the water, condensation – in the form of beads of water or fog – will appear either on the inside or outside of the glass. This activity demonstrates water changing states based on temperature and explains why we see drops of dew outside in the morning!

INQUIRY QUESTIONS

Getting Started:

❓ What are the states of matter and how do we describe them?

Learning More:

❓ How can matter change between states, and what are these processes called?

Diving Deeper:

❓ How does energy and particle motion relate to states of matter and changes in states of matter?

CONTENT TOPICS

This activity covers the following content topics: states of matter, physical changes, condensation, vaporization, atomic structure, energy, temperature, heat

This activity can be extended to discuss: water collection methods, sublimation, deposition, photosynthesis, plant structure and functions, animal behavior, dew point, weather, climate, intermolecular attraction, hydrogen bonding

NGSS CONNECTIONS

This activity can be used to achieve the following Performance Expectations of the Next Generation Science Standards:

- 💡 **2-PS1-4:** Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.
- 💡 **5-PS1-1:** Develop a model to describe that matter is made of particles too small to be seen.
- 💡 **MS-PS1-4:** Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

MATERIALS

For one setup:

- ✔ Clear glass jar with lid
- ✔ Ice
- ✔ Hot and cold water

ACTIVITY NOTES

This activity is good for:

- ✔ Pairs
- ✔ Small groups
- ✔ Large groups
- ✔ Demonstrations

Safety Tips & Reminders:

- ⚠ If you are having trouble getting the experiment to work, try it in a humid environment like a kitchen or bathroom.
- ⚠ Do not use boiling hot water for this activity, as it can melt the plastic cup.
- ⚠ Review the Safety First section in the Resource Guide for additional information

Fun Fact #1

Dew can be a powerful resource for farming in arid climates. If the dew can be trapped and collected, it can be used to water plants and even as drinking water!

ENGAGE

Use the following ideas to engage your students in learning about the chemistry of life and Earth sciences::

- ✿ If it is early enough in the day, take students outside to a grassy area. Why do they think the grass is wet if it did not rain? Where does the moisture come from? Why do we only see it in the morning? If you are meeting with students later in the day, you can start by asking them if they have noticed this phenomenon or show pictures of it to spark their memories and a discussion.
- ✿ To engage prior learning, start with The Moving Molecule Stomp Activity Guide to show how particle motion changes between states and as energy changes occur.
- ✿ Show pictures of common example of condensation, such as beads of water on containers left outside, water pooling on a table around a glass of ice water or fogged up mirrors and windows. When have students noticed these phenomena in everyday life? Can they explain what is happening ?

See the Elaborate section of this activity for more ideas to engage your students.



EXPLORE

Procedure:

1. Fill jar halfway with hot water.
2. Put a lid on the jar, then place it on a table and observe.
3. Next, pour the water out of the jar and dry completely.
4. Fill jar halfway with cold water and ice cubes.
5. Put a lid on the jar, then place it on a table and observe.

DATA COLLECTION & ANALYSIS

Analyze and discuss the results of this activity using the following questions:

- Draw diagrams of water as a solid, liquid, and gas. What does each look like and what is different? At which temperature would you find each example?
- Make a prediction: what will happen when you fill the jar with hot water? What about ice water? Why?
- Draw a picture and describe what you see when the jar is filled with hot water and when the jar is filled with ice water. Is each similar or different from your predictions?

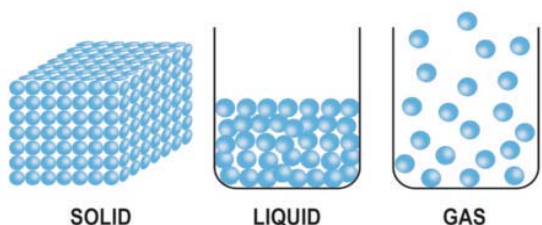
Notes

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First review the Chemistry of Life & Earth Sciences Background section to gain a deeper understanding of the scientific principles behind this activity.

All matter on earth exists in three forms: solid, liquid, or gas. Each state of matter has its own properties:

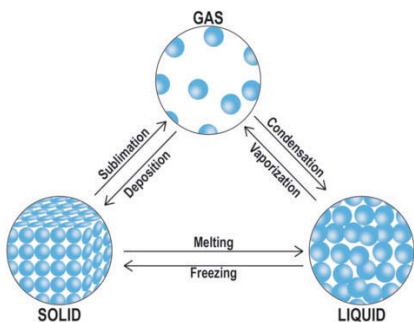
- **Solids** have defined shape and volume. In a solid, particles are vibrating in place and at their lowest energy state. Examples of solids are ice cubes, wood, and steel.
- **Liquids** have a defined volume but no defined shape; they take the shape of the container they are in. In a liquid, molecules have more energy than in a solid, they move faster, and flow around one another. Examples of liquids are water, juice, and oil.
- **Gases** do not have a defined volume or shape. Gas particles have more energy than particles in a liquid, and they move in all directions at high speed. Examples of gases are oxygen, helium, and water vapor.



Matter can change from one state to another when it gains or loses energy. For example, when water molecules (comprised of two hydrogen atoms and an oxygen atom – H₂O) have the least amount of energy and are at a low temperature, they are a solid: ice. As more energy is added to the ice – for example, if the ice is heated – the molecules gain energy and move more freely. Once the molecules have enough energy to break free of the bonds holding them tightly in solid form, the ice becomes liquid, which we know as water. If more heat is added, the liquid water eventually turns to gaseous water vapor, which we call steam. Water easily moves between states from a solid, to a liquid, and finally to a gas as heat is added and the H₂O molecules gain energy to move more freely, faster, and further from one another.

The reverse process of a gas becoming a liquid and then a solid is also possible. As energy is removed, such as through cooling processes like refrigeration or freezing, the H₂O molecules slow down and move closer together. When water vapor gas is cooled it becomes liquid water, and if the liquid water is cooled further it becomes solid ice once more.

There is a specific name given to each phase change. When a solid becomes a liquid we call it melting, and when a liquid becomes a gas that is evaporation (also known as either boiling or vaporization). For the reverse processes, when a gas becomes a liquid that is condensation, and when a liquid becomes a solid that is freezing. In rare cases, a solid can directly into a gas (sublimation) and a gas can turn directly into a solid (deposition).



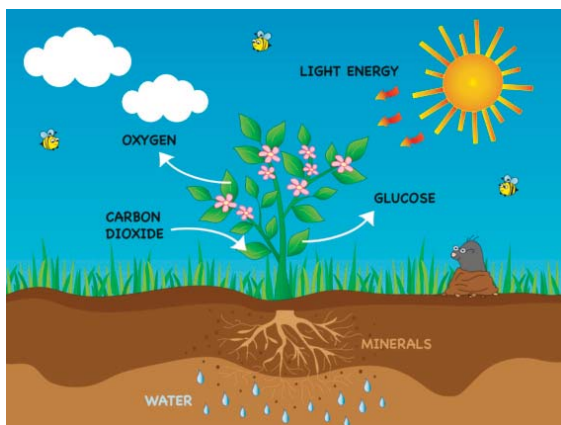
EXPLAIN continued

In this activity, when there is hot water in the jar, the inside of the glass fogs up. This happens because the hot water releases water vapor (steam) and warms the water vapor already in the air in the glass. Those warm water vapor molecules move around the inside of the jar, and when they touch the room-temperature glass they get colder and condense from a gas to a liquid. As the water vapor condenses, it loses energy to the colder glass. The fog you see in the jar is the liquid water droplets forming as water vapor cools.

In the next phase, ice water is put into the jar. This time, you will see droplets of water forming on the outside of the jar. The ice water inside the jar cools the glass, so when warmer water molecules in the air touch the glass they condense into liquid on the outside of the cup.

If you are an early riser, you have likely experienced this phenomenon already! When the sun goes down at night and the environment cools, water vapor in the air condenses into liquid. We see this in the morning as **dew** on surfaces outside. If you live in an area that gets cold, you will see this as **frost**. As the sun comes up and provides energy through heat, the dew usually evaporates and becomes water vapor in the air, and the frost usually melts.

In places that do not get a lot of rain, the formation of dew is important because it allows plants and animals to access liquid water they need to survive. For example, in desert climates plants are known to use fog or dew as sources of water for **photosynthesis**, which is the chemical process that a plant uses to make sugars.



ELABORATE

Elaborate on your students' new ideas and encourage them to apply them to different situations. The section below provides some alternative methods, modifications, and extensions for this activity.

- Set up the activity with the hot water and ice water jars at the same time so students can compare the results side-by-side
- Try the experiment with different containers: metal cans, plastic bottles, paper cups – whatever you can find! Which worked best and why?
- Connect this experiment to learning about other types of moisture that are found in the environment, including humidity, rain, snow, sleet, glaze, hail, clouds, and much more!

Fun Fact #2

Rain occurs when water vapor in the air condenses from a gas, back into a liquid form, and leaves the atmosphere, returning to the surface of the Earth in a process known as the water cycle.

Differentiation for Younger or More Advanced Students

You can differentiate this activity for students of different grade levels by focusing on the concepts outlined below.

GETTING STARTED

For younger students, emphasize the following concepts:

- Matter exists in three states: solid, liquid, and gas.
- Each state of matter has its own properties.
- Matter can change between the states due to changes in energy, such as heat.

DIVING DEEPER

For more advanced students, emphasize the following concepts:

- Particles in each state of matter behave differently.
- As energy is added or removed from a system, matter changes state as particles gain or lose energy.

CHEMISTRY IN ACTION

Share the following real-world connections with your students to demonstrate how chemistry is all around us.

Real-World Applications

Have you ever blown air onto a mirror or window to fog it up? When you do this, water vapor on your breath is condensing on the cool mirror or window surface! The same process happens in homes and buildings. On cold days water droplets might form on the inside of the windows, and on warm days if the air conditioning is water droplets might form on the outside.



Have you ever followed the path of an airplane through the sky by watching its trail? These trails are a type of cloud called a cirrus cloud. They are formed when jet exhaust from the plane encounters cold air in the sky, condenses into water droplets, and then freezes to form ice crystals.



Careers in Chemistry

- Car manufacturers have to build systems that quickly and efficiently remove moisture from car windows, since they can impair a driver's vision on the road. Car defrosters perform a variety of functions: some warm the window to evaporate moisture and remove ice, others pass dehumidified cold air that can absorb moisture from the windows.
- Sick of your cold drinks "sweating" on your tables? Double-walled cups have been designed to keep the outside of the cup at room temperature, so no condensation forms. The double wall also acts as an insulator, which keeps your hands from getting too cold or hot while enjoying your drink!
- Have you ever been on a plane and noticed the tiny "breather hole" in the window? Aerospace engineers and window manufacturers have included this feature has a number of purposes: it equalizes the pressure between the cabin and the air gap between the window panes, and it also releases moisture to keep your view free of frost or fog!



EVALUATE

- Provide a scenario to students: they come home and notice that there is a glass of room-temperature water on the table, and it is sitting in a small pool of water. What do they think happened? Why? Which part of the experiment is similar to this scenario?
- Explore where condensation forms in the local community. Ask students to keep a science journal for the week and note every instance of condensation they see in their environment, either in human made or natural objects. At the end of the week they can share their findings with the class. Did anything surprise them? Where was condensation frequently found? Where was it never found? Why do they think that is?
- Can students draw the three states of water and name the processes of changing between states? See how far they can get from memory, and provide clues as needed. For more advanced learners: can they draw how particles are arranged and show their motion? Where is energy being added, and where is it being removed?

Fun Fact #3

When you take a hot shower, the mirror or bathroom window usually gets foggy. The "fog" is actually condensed water vapor.