

Moving Molecule Stomp

Section PROPERTIES OF MATTER *Topic* STATES OF MATTER

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

OVERVIEW

Explore the differences between the motion of particles in solids, liquids, and gases by using students as models.

This activity demonstrates the physical differences in the solid, liquid, and gaseous states of matter by using students to represent the movement of particles in each state. The different states have unique characteristics depending on the movement of their particles. Students will see that as particles gain energy and move at a faster rate, matter can change between different states.

INQUIRY QUESTIONS

Getting Started:

❓ What makes something a solid, liquid, or a gas?

Learning More:

❓ Why does matter exist in different phases?

Diving Deeper:

❓ What factors can affect phase changes between states of matter?

CONTENT TOPICS

This activity covers the following content topics: states of matter, energy, phase changes

This activity can be extended to discuss the following: conversion of energy, energy transfer, phase change diagrams, crystalline solids, amorphous solids

NGSS CONNECTIONS

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

- 💡 **2-PS1-1:** Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.
- 💡 **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 setup:

- ✔ Space for students to move around freely

Optional materials:

- ✔ Ice
- ✔ Water
- ✔ Beakers
- ✔ Hot plate & pan

ACTIVITY NOTES

This activity is good for:

- ✔ Demonstration
- ✔ Whole class activity
- ✔ Concept introduction

Safety Tips & Reminders:


- ⚠ You will need plenty of space for students to move around. If space is limited, try doing this activity with a smaller group or as a demonstration.
- ⚠ Remind students to be safe as they move throughout the space.
- ⚠ Review the Safety First section in the Resource Guide for additional information.


Fun Fact #1

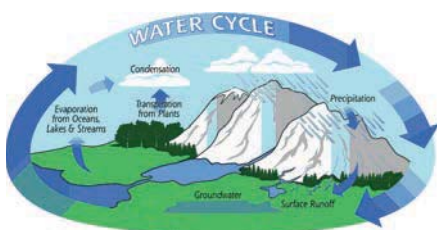
Though we usually think of there being only 3 states of matter, there is actually a fourth! Plasma is similar to the gaseous state, however the particles have electrostatic charges. It makes up the sun and stars and is the most common state of matter in the universe as a whole.

ENGAGE

Use the following ideas to engage your students in learning about states of matter:

 Present your students with examples of matter in different states, focusing on the differences between the three primary states: solid, liquid, and gas. Next, show a single substance at different states of matter. For example, show water as ice, water, and water vapor. Ask students to discuss the differences between the three states of matter, and see if they can conclude why water could exist in three different states. Explain that these changes occur because of changes in energy.

 Use the water cycle to demonstrate matter changing between different states. Why is matter able to change from one state to another? Water can turn from a liquid (rivers, oceans, rain), to a gas (water vapor forming clouds), to a solid (snow and ice) in nature. Why do these changes occur?



See more ideas for engagement in the States of Matter Background section! You can also look at the Elaborate section of this activity for other ideas to engage your students.

Fun Fact #2

It is possible to turn a gas into a liquid by compressing it (making the container that holds it smaller).

The opposite is also possible. Propane tanks are filled with liquid propane, but when the propane is released, it becomes a gas again because the pressure has decreased and the particles are free to move around.

EXPLORE

Procedure:

Solids

1. Have the students stand closely in one part of the room.
2. Instruct students to softly and slightly sway without moving their feet.
3. Ask students what state of matter they represent.
 - At this point, they represent particles in a solid: close together, tightly packed, and relatively motionless.

Liquids

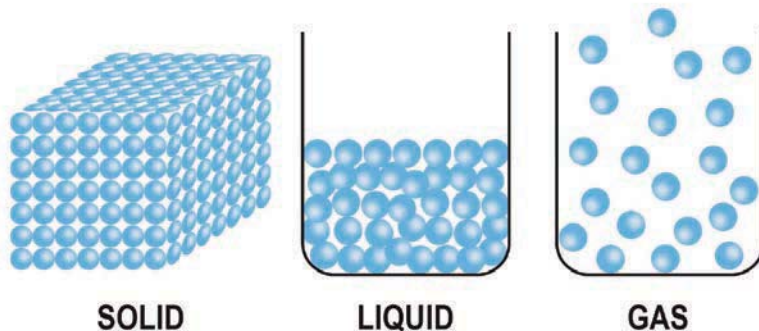
4. Ask the group what would happen if the particles had more energy and they were able to increase their movement.
 - Supplying the particles with more energy will change them to the next state of matter – liquid. Tell students they have been energized so they can start moving their feet, but stay together in the same area. Have them start walking slowly. They are allowed to move past one another, but they must always have at least one student within arm's length.
5. Ask students what state of matter they represent.
 - At this point, they represent particles in a liquid: they have more energy and are not as tightly packed because they can move around. Like particles of a liquid, they are still connected to each other and contained in their container or area.

Gases

6. Instruct students that they have even more energy than before. Ask the group how they would feel with more energy: energetic, like running around.
7. Tell students to move around the entire room, now walking at a normal speed.
8. Ask students what state of matter they represent.
 - At this point, they represent particles in a gas: the particles are free to quickly move anywhere they want because they have so much energy.

 **Remind students to be careful as they move about the room and demonstrate the movement of particles. They should be reminded not to run, and to slide past one another gently.**

Increasing Energy



DATA COLLECTION & ANALYSIS

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

- What do particles in a solid look like? What about particles in a liquid or gas? Draw the arrangement of particles in each state of matter.
- Describe the properties of each state: solid, liquid, gas
- Which state of matter has the most energy? Which has the least?
- What is required for a substance to change states? Explain.

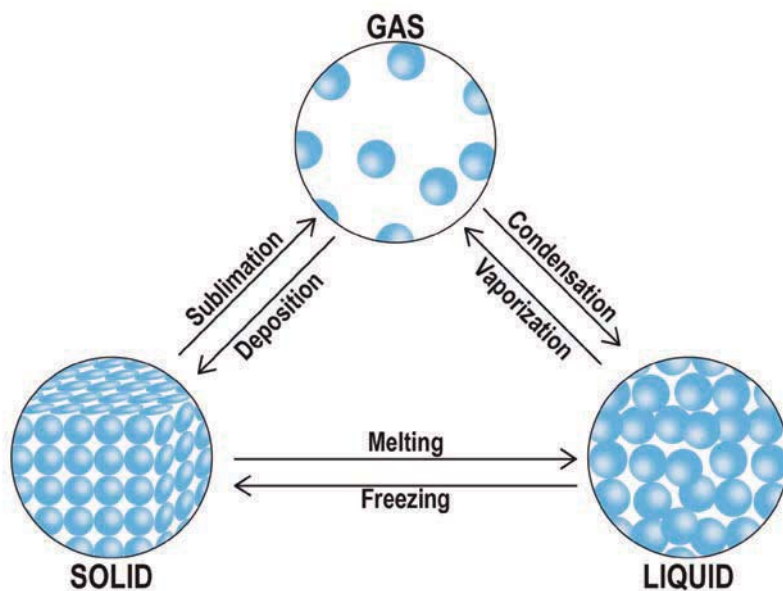
EXPLAIN

What's happening in this Activity?

First review the States of Matter Background section to gain a deeper understanding of the scientific principles behind this activity.

Matter exists in one of three major states: **liquid**, **solid**, or **gas**. **Solids** have definite volume and definite shape. Particles in a solid are locked in place, although they vibrate slightly, and are more tightly packed together than those in liquids or gases. **Liquids** have a definite volume, but no definite shape. A liquid will take the shape of whatever container it is in, but its volume will not change. Particles in a liquid are in constant random motion and move more than those in solids. **Gases** have no definite volume and no definite shape. A gas will fill the shape of its container, and will change in volume depending on that container as well. Gas particles have weaker attractions between them than solid or liquid particles, which allow them to move quickly in random directions and over larger distances.

Matter can undergo a change of state, or a **phase change**, when energy (often in the form of heat) is added or removed from the substance. An increase or decrease in energy causes the particles in a substance to move faster or slower. This changes the way they are bonded together and structured, which is part of what defines each state of matter.



All matter is made up of tiny particles that are always in motion. Even though we can't see these tiny particles, we can demonstrate the differences between particles in gases, liquids, and solids using other objects. In this activity, students represent the movement of particles in a substance. As they move around the room with different amounts of energy, they represent particles in different states of matter.

When students start out, they are packed tightly together. They can move in place, but cannot pick up their feet and move past one another. This is true of **solid** particles. Particles in a solid vibrate in place but are locked in position. Students' increased ability to move shows that they are gaining energy. The more energy a particle has, the more it can move and overcome the attractions between particles in a substance.

In the next part of the activity, students are able to walk short distances, but still remain together in a clump. **Liquid** particles can move more than solid particles, and can even move past one another. However, they are still somewhat bound by the attraction between particles and cannot move long distances. In the final stage of the experiment, students

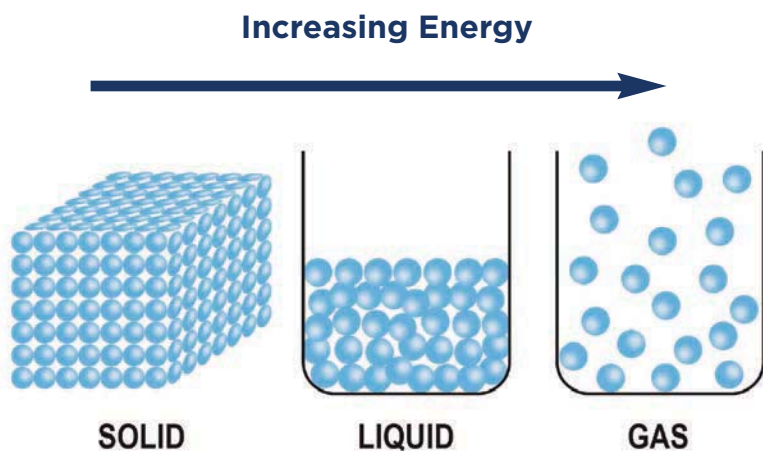
Fun Fact #3

Coconut oil can be found as both a solid and a liquid in your cupboard. This is because it has a melting point of 24 °C (76 °F), while room temperature is taken to be an average of 23 °C (74.3 F). If the room gets too warm coconut oil will turn from a white solid to a clear liquid.

Although matter on Earth is typically categorized by the three major states of matter, there is also a fourth state of matter called **plasma**. **Plasmas** are ionized gases. Some electrons in plasma are free, which means they are not bound to an atom or molecule. Plasma is the most abundant phase of matter in the universe. Plasma can't be described just by how much energy its particles have and how tightly packed they are—it is more complicated, and difficult to demonstrate with students.

Temperature is a measure of the average kinetic energy (energy of motion) of particles in a substance. It is a measure of how fast the particles are moving around. At higher temperatures, the average kinetic energy of particles is higher, so particles in the substance are moving around at a faster rate than at lower temperatures.

You can see the relationship between energy (due to the increase and decrease in temperature) and the movement of the particles at each phase. For example, as the water increases in temperature, the particles begin to move at a faster rate, and over a longer distance, and eventually evaporate to become a gas.



Remember that when matter changes state because it gains or loses energy, its molecule's speed changes but its chemical makeup remains the same. For example, water is still H_2O both before and after it freezes.

Notes

[illegible]

EXPLAIN continued

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 is made up of particles too small to be seen. These particles are always in motion.
- Matter can exist in different phases.
- Particles in matter of different phases have different amounts of energy.
- Matter can change between different states of matter because of changes in energy.



DIVING DEEPER

For more advanced students, emphasize the following concepts:

- Temperature is a measure of the average kinetic energy found in particles of a substance
- Changes of state due to variation in temperature and pressure can be predicted through models
- Substances have unique temperatures at which they change state, and can be identified by these properties (boiling point, melting point).
- Phase changes are physical changes and not chemical changes.

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.

- Have students do this activity from their seats. Students can sit still and hold their arms close to their chest to represent a solid. Students can spread out their arms and move them lightly to represent solids. A gas can be represented by having students spread out their arms as far as possible and moving their fingertips.
 - Do this activity with balloons! Use clear trash bags and balloons to demonstrate the different states of matter. Have students stuff different amounts of balloons into three different trash bags to represent particles in the solid, liquid, and gas state.
 - Explore how pressure can affect the phase in which you find certain types of matter. Show a video showing how compressing a gas can turn it into a liquid for easier storage (example – propane tanks). Ask your students to analyze and discuss why pressure can affect phase changes.
 - Give each student a bag with a few ice cubes in it. Have a competition to see who can melt it the most in ten minutes. After ten minutes, measure the amount of water in each student's bag. What worked best? Why? Where did the heat come from? Discuss how their bodies produce this energy. At the end of the activity, you can place some water in a beaker on a hot plate and heat it until water vapor rises from the beaker. Tell the students that they are watching a liquid changing to a gas.
-  Instruct students to put the ice down on their desk if their hands get too cold or start to ache. Have paper towels, cups, and/or plates available for students.**
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EVALUATE

- As a take-home assignment, have students categorize household items into each state. Students can also try to identify something in their home that can change into all 3 states. Is there anything that is hard to categorize? Why?
- As a project, have students create a model that shows the three different states of matter. They can use any crafts you provide to develop their solid, liquid, and gas models.
- Have students apply their new learning to a real-world chemistry connection. Other than the water cycle, what are some examples of phase changes in our lives? Have students come up with or research some examples of phase changes in our lives, and explain what changes occur as the states change from one to another.

Real-World Applications

Careers in Chemistry

- Chemists can use gas chromatography (GC) to identify volatile substances (substances that evaporate easily at room temperatures). A liquid that is often a mixture is injected into a gas chromatography machine and evaporated into a gas. As a gas, the different kinds of molecules found in the liquid sample can be separated and identified more easily, so chemists can use this to identify the different components in their sample. For example, food chemists can use this process to identify what molecules cause certain flavors and aroma in food.

Notes