

Plasma: It Matters

Overview:

Many people know about the three states of matter: solid, liquid, and gas. The fourth state, plasma, is less understood. Plasma plays a significant role in the aurora phenomenon. Students classify characteristics and examples into four categories that represent the states of matter.

Objectives:

The student will:

- recall and record items from a visual aid;
- assign categories to a list using inductive reasoning;
- identify examples of the four states of matter; and
- compare chemical units of matter (molecules, atoms, electrons, protons, neutrons) and states of matter.

Materials:

- Shoebox
- Mesh
- Hair dryer
- Tape or stapler
- Gumdrop molecule example from Unit 4: *Particles*
- VISUAL AIDS: “A,” “B,” “C,” “D,” and “States of H₂O”
- STUDENT WORKSHEET: “Guess My Rule”
- 8-1 1/2 inch Styrofoam balls
- 8- 1 in. Styrofoam balls
- 8-1 1/2 inch pins

Answers to Student Worksheet:

<p><u>Items from “A”</u> <i>rock, ice, nail, wood, pencil, mittens, salt, glass, fabric or blanket</i></p>	<p><u>Items from “B”</u> <i>milk, rain, waterfall, lava, sprinkler, gasoline, juice</i></p>
<p><u>Items from “C”</u> <i>water vapor, helium balloon, oxygen tank, hot air balloon, raft, propane tank</i></p>	<p><u>Items from “D”</u> <i>lightning, the sun, aurora, flame, neon sign, solar wind, fluorescent light, plasma lamp</i></p>

Categories:

1. *Solids*
2. *Liquids*
3. *Gases*
4. *Plasmas*

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Teacher Information:

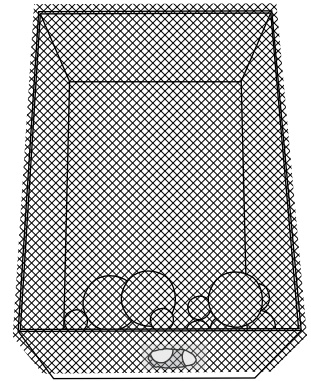
Plasmas make up 99% of the visible universe. Yet, this state of matter can be difficult to understand because of its rarity on Earth and its fleeting and distant occurrence in nature (lightning and aurora). It is also very similar to gases at first glance, but a closer examination reveals unique properties.

The goal of this lesson is to connect the idea of plasma to common states of matter on Earth (solids, liquids, and gases) by examining examples, and differentiating between particles in plasma and molecules or atoms in gases.

Activity Preparation:

Make the box for modeling plasma behavior. This will be used in Part 2 of the activity. See the photos below for reference.

1. Remove the top from the shoebox then cut a hole in the side of the box that is the diameter of the hair dryer.
2. Cut out a piece of mesh that covers the hole for the hair dryer and the top of the box.
3. Attach the piece of mesh that covers the hair dryer hole with staples, glue, or tape.



Activity Procedure:

Part 1—Worksheet and Visual Aids:

4. Distribute STUDENT WORKSHEET: “Guess My Rule.”
5. Explain that the teacher will display a VISUAL AID for about 5 seconds. Students are to recall and record as many items as possible in the appropriate box on the STUDENT WORKSHEET. The teacher will repeat this process with the three other VISUAL AIDS.
6. Show the VISUAL AID: “A” with the examples of solids on it first. Do not tell the students that all the items on the overhead are solids.
7. Display the VISUAL AID: “B” with the examples of liquids next.
8. Then display VISUAL AID: “C” with examples of gases next.
9. Finally, display VISUAL AID: “D” with the examples of plasmas last.
10. Assign a minute for students to analyze the list and name possible categories to the lists. Students can pair up and compare lists.
11. Review the information to enable students to compare their lists and possible categories.

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Part 2—Classroom Discussion and Demonstration:

1. Explain that on Earth, the most common types of matter are solid, liquid, and gas but the most common type of matter in the visible universe (99%) is plasma. Use VISUAL AID: “Phases of H₂O” to explain the states of a common substance, H₂O, and the temperature associated with the states. When moving along the continuum from solid towards plasma, more energy is necessary. Use the gumdrop model to explain that although atoms can be joined together to form molecules, an individual atom can be broken down into smaller units. These smaller units are what we refer to as particles. When explaining plasma, use the Styrofoam™ model to illustrate that a hydrogen atom can be broken down into smaller units. The larger piece is a model of the nucleus, which contains a proton and sometimes a neutron. The proton has a positive charge and the neutron has no charge. The small Styrofoam™ ball orbits the nucleus and is called the electron. The electron has a negative charge. Other atoms are broken down when transforming into plasma, but the small size of a hydrogen atom makes the process easier to illustrate.
2. Explain that the purpose of the following demonstration is to observe how models of hydrogen atoms can be separated at high temperatures.
3. Attach the Styrofoam™ models of hydrogen with pins. Place them in the shoebox and tape the screen over the box.
4. Blow air into the box on a low setting. Next, blow air into the box on the high setting. The Styrofoam™ models of hydrogen atoms should blow around inside the box like a gas on the low setting. As the heat increases on the high setting, the atoms are unable to stay together, so the bond between electrons and the nucleus becomes weaker and they split apart.
5. Ask students to consider the following questions:
 - What do the small Styrofoam™ balls represent? (Electrons)
 - What do the large Styrofoam™ balls represent? (Protons)
 - Which state is modeled when the atoms are being blown around on the low setting? (Gas)
 - Which state is modeled when the atoms are being blown around on the high setting? (Plasma)
 - What is the difference between a gas and plasma? (A gas is mostly made of atoms and/or molecules. Plasma is made of particles of an atom.)

Guess My Rule

Directions: The teacher will very briefly display four overhead transparencies. Try to recall as many items as possible and record as a list in the appropriate box.

<u>Items from "A"</u>	<u>Items from "B"</u>
<u>Items from "C"</u>	<u>Items from "D"</u>

Categories: Analyze the lists above and try to assign a category to each box.

1. Items from VISUAL AID "A" _____
2. Items from VISUAL AID "B" _____
3. Items from VISUAL AID "C" _____
4. Items from VISUAL AID "D" _____