GENERATIONGENIUS
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LESSON PLAN

PARTICLE NATURE OF MATTER
GRADES 3-5

SUMMARY

Students model the structure of gases and other materials which are made up of particles too small to be seen, and use that model to explain properties of those materials. Students first physically model the particle nature of solid, liquid and gaseous phases of water, but move on to observations of phenomena can be explained through the particle model of matter.

NEXT GENERATION SCIENCE STANDARDS CORRELATION

5-PS1-1 Develop a model to describe that matter is made of particles too small to be seen.

Science & Engineering Practices	Connections to Classroom Activity
Developing and Using Models (5-PS1-1)	• Create and use models they draw, models they participate in, and two and three-dimensional models on the video to help them describe the particle nature of matter.
Disciplinary Core Ideas	**Connections to Classroom Activity**
PS1.A: Structure and Properties of Matter Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around	• Study the particle model of matter by observing a variety of phase changes and demonstrations that can be explained by that model even though the particles are too small to see. • Explore the idea that gases are made of particles that are too small to be seen by observing materials

in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects.	in solid, liquid and gaseous forms and using particle models to explain their behavior.

Crosscutting Concepts	Connections to Classroom Activity
Scale, Proportion, and Quantity (5-PS1-1)	• Students use the properties of matter as evidence for small particles that make up the materials around us.

DURATION

One to two 45-minute classroom periods

PRE-ASSESSMENT QUESTIONS

Please see Discussion Questions. These can be discussed as a group or answered individually in student science notebooks.

MATERIALS

- Dry ice (can be substituted with video)
- Video link - https://youtu.be/C4pNT6KGYiI
- Oven mitt or gloves
- Hammer or mallet
- Plastic bowl
- Glass flask or small-mouthed vessel
- Balloon
- Chalk or masking tape
- Science notebooks
- Pencil

ENGAGE

(If you do not have access to dry ice, use the video provided instead. Use the questions from below while watching and discussing the video.) While dry ice is inside its packaging, use a hammer or mallet to break some small chunks off. Make sure some are quite tiny. Using an oven mitt, place various-sized pieces of dry ice in a shallow bowl. Instruct students to gather around the bowl but not to touch the ice. Show them the dry ice in the bowl.

Ask:

- What do you think the dry ice is made of? (Some students may know it is solid carbon dioxide).
- How small do you think a piece of dry ice could be broken, and still be dry ice?

Ask students, “What is happening here?” Many students may be aware that the solid carbon dioxide is changing directly into its gaseous form, but it is important to explain to the class that the dry ice is changing from a solid to a gas. You might also ask students, “Where do the pieces of dry ice go when they become a gas?”

Next place a few small pieces of dry ice inside a glass flask and quickly seal the flask with a balloon. The balloon should begin to inflate and the ice should disappear. The process is slow. Ask students, “Are the pieces of ice now inside the balloon?”

EXPLORE

In their science notebooks, ask students to sketch what they think the carbon dioxide gas would look like inside of the balloon if they were able to see it. Ask them to explain what they think the gas inside the balloon is doing. They may find this confusing. Tell them if they think there is nothing going on inside the balloon, to sketch an empty balloon. Remind them to think about where the pieces of dry ice went.

Next, students will become part of a human model of solid, liquid, and gas. Students should have some understanding that solids melt into liquids when heat is applied, and liquids evaporate into gases as heat is increased. Ideally, they should also understand that as temperature decreases, gases condense into liquids and then liquids freeze into solids. Explain to students that they will first model water and then move on to carbon dioxide to see if they can figure out what happened to the dry ice.

Explain that students are first going to represent an ice cube. Ask the group how they could arrange themselves to represent ice. Gently guide the students into a tight bunch if they don't figure this out on their own. Explain that in this example, students represent water particles locked in place as solid ice. Next instruct students that you are turning up the heat. Ask, "What happens to ice when the heat is turned up?" Explain that ice melts and the particles start to move more. Let the students decide how to represent melting into water. Encourage discussion and argumentation with reasoning. Then explain that you are turning up the heat some more. Ask students to predict what will happen now that the heat is higher. Again, let students work through it with your facilitation. When they are finished, explain that particles move faster and spread out further, representing gas.

Take a break and have students sketch how they modeled solid ice, liquid water, and water vapor in their science notebooks. Tell them they can use dots to represent students.

Instruct students to use the ideas from their model of water to explain what is happening with carbon dioxide. First, discuss how carbon dioxide changes phases.

Ask:

- Did you observe the dry ice melting into water before it became a gas? (No, it sublimated directly from a solid to a gas, skipping the liquid phase.)
- How will you represent dry ice? (Students should pack together tightly as they did for solid water.)
- What happens when the dry ice changes directly to gas? (Students should think back to how they represented water vapor.)

Next add the flask and balloon into the model. Use chalk to draw an outline of the flask and the balloon, large enough for the class to fit inside. Masking tape can be used indoors. Students should start out clumped together in the flask and then break apart spreading out into the balloon.

Ask students to add a sketch of their model for dry ice and carbon dioxide gas to their science notebook.

EXPLAIN

WATCH THE GENERATION GENIUS PARTICLE NATURE OF MATTER VIDEO AS A GROUP.

Then facilitate a conversation using the Discussion Questions.

Now students should be able to explain what they observed with the balloon using the particle model of matter. They can determine whether their human model depicted what happened accurately and make tweaks as necessary. This should be a student-driven activity and, at the end, students should redraw or make modifications to their original sketches in their notebooks to show what happens to the particles as solid carbon dioxide (dry ice) becomes a gas and fills up a balloon. Ask students, "What do you think will happen if you now tie off the balloon and put it in the freezer?" (The balloon should shrink, but the temperatures in a freezer are not low enough to cause the dry ice to become a solid again. That is why Dr. Jeff had to use liquid nitrogen for his demonstration.)

ELABORATE

Use the DIY Activity to create fizzy tablet rockets just like Zoe's from the video. Then students should sketch what happened inside their rocket in their science notebooks, using the particle model of matter.

EVALUATE

In their science notebooks, students use the particle model of matter to explain why the balloon in the vacuum chamber from the video expands when the vacuum pump is turned on, and returns to its original size when the air is let back into the chamber. They can include drawings (models) along with their written explanation.

Then students should choose one of the other items that was placed in the vacuum chamber (gummy candy, cream filled snack cake, shaving cream, or marshmallow) and explain what happened to it using the particle model of matter. For example, each of these materials contains gases. When the air in the chamber is removed it provides space for the gas particles inside the candy, cake, shaving cream, or marshmallow to spread out further and fill up the empty space. The least amount of gas is found in the gummy candy, so it spreads out the least. The cream in the cakes contains more gas than the cake so it expands out of the cake. Students can also include drawings (models) in their explanations.