Performance script for sixth graders

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[Remember to get answers from a wide variety of students in the audience. Don't call on the same ones each time. Walk the students through the answers with hints, don't give them answers if they don't get the right away, give them time to think as well before giving them hints. Give all answers positive confirmation even if they are wrong. Repeat all answers out loud so that the whole audience can hear them. Have fun, people having fun keep an audience's attention much better.]

{Preparations}

[Materials: LN2, cryogenic gloves, Styrofoam container, balloon, flowers, racquetballs, ice cream materials, two balls, model of molecules, giant thermometer with moveable temperature gauge]

[Before the presentation, pour liquid nitrogen into Styrofoam container and place racquetball inside. Set container aside.]

{Introduction}

[Introduce yourself to the students. (name, first says grade and school)]

{What is matter - made up atoms}

A: We're here today to show you some neat demonstrations about the states of matter. So to start, we ask, what is matter? [Get answers from kids, only a couple]

B: It's all the substances around us. All these things that we can see and even some that we can't. The tables are matter, the nearby ocean, and even the air we breathe. What do these things have in common? They are made up of building blocks called atoms.

C: Atoms are the basic ingredients of all matter, but you can't see them because they are VERY, VERY small. How many atoms do you think will fit across the width of a single hair? [Get guesses from class.] It's about 1 million atoms. Since we can see them, we can use a ball to help us think about atoms. [Hold up a ball representing an atom.]

D: Atoms don't have to go through life alone. Sometimes they bond together to form molecules like this. [Hold up model of molecules.] This specific molecule has several atoms bonded to each other. [Point out atoms and bonds as you mention them.] All matter is made of combinations of atoms and molecules.

A: Different types of matter like this table and this floor are made of different types of atoms and molecules.

{States of Matter}

B: Matter made out of the same molecules can sometimes look and act very differently. Can you think of something that might have the same molecules but look different? [Encourage students to think of examples, take responses] [Example Hint: Think of your freezer, something that might have a different form inside and outside of the freezer]

C: One good example is water. Water -. The three most common states of matter are solid, liquid, and gas.

D: Can you give me another example of a solid? (take 1 or 2 answers)

A: What about an example of a liquid? (take 1 or 2 answers)

B: What about an example of a gas? (take 1 or 2 answers)

C: What determines the state of a substance? The movement of its atoms or molecules.

D: In a solid, the atoms stay next to each other and vibrate in one spot, [Hold up and demonstrate with two balls] like these two atoms.

A: In a liquid, the atoms stay close together, but move around, bumping into each other, [Hold up and demonstrate with two balls] as these two atoms are currently doing.

B: In a gas, the atoms are spread far apart and move quickly, [Demonstrate with 2 balls] like these two atoms.

{Temperature}

C: There is a simple device that probably everyone has in his or her home that describes how fast atoms and molecules move. Can anyone guess what this device is? [Possible hint: How is ice, water, and steam different? Then what instrument can we use to tell.] [Keep giving hints until they get it. Try to let them give all the answers]

D: That's right, a thermometer. A thermometer measures temperature. You might have put one under your tongue the last time you were sick to measure your body temperature.

A: Scientifically speaking, temperature is a measure of the energy of the motion of the atoms or in other words, the thermometer measures how fast the atoms or molecules in a substance are moving.

B: [Use balls to demonstrate this as you say it] Atoms moving very fast have more energy, and thus a high temperature. Atoms moving very slowly have less energy, and thus a low temperature.

C: According to this, can you arrange the states of matter from most energy and temperature to least? [Take answers.] Right, gasses have the most energy, then liquids, and then solids have the least amount of energy.

D: If we look around this room, we can see solids, liquids, and gasses at the same time. This means that at a specific temperature, different substances may have different states of matter.

{Changes of state}

A: Matter isn't stuck in one state. One way to change the state of something is by changing the temperature, which we can do by placing it next something else that has a different temperature.

B: When two things next to each other are at different temperatures, the heat energy from the hotter object flows into the colder object. For example, when you put ice into cup of water, the heat of the water flows into the ice and eventually melts the ice.

C: If we could look at the molecules, we would see that water has atoms that are moving quickly. When they collide with the slower atoms in the ice, it slows down the faster atoms and speeds up the slower atoms. After a while all the atoms will be moving the same speed, which means they're at the same temperature. When this has happened, the ice has melted and the water is cooler.

D: When a lot of heat is applied to a solid, its atoms will move faster until it is a liquid. This is called melting. Similarly, when a liquid is placed in someplace very cold, the motion of the atoms will slow down until it becomes a solid. This is called freezing.

{Kids as atoms}

A: To demonstrate this, we're going to need some volunteers to be atoms in the solid, liquid, and gas forms of water. [All fellows help gather a group of 5-10 students at the front.]

B: We'll start with a few people as a solid. Stand next to each other, and shake in place. [Fellows and students help by demonstrating] (Have giant thermometer board and start with temperature at 0)

C: We increase the temperature by adding atoms that are moving very fast. These atoms bump into the solid, they break up and everyone moves around each in what is now a liquid. [Move thermometer up to 50] [Liquid atoms will be able to walk slowly around each other, but in a region in the front.]

D: We can increase the temperature again with even faster atoms. These will bump into the liquid making all the atoms move fast and then spreading across the room. This is

now a gas. [Move thermometer to 100] [Gas atoms will be able to walk quickly and encourage them to walk all over the room]

A: So if you were to put an ice cube in a pot and pot on a stove and turn it on, this is what the water molecules would do. Let's thank our atoms. [Applause and encourage the atoms to sit down.]

{Liquid nitrogen}

B: Now that you know the different states of matter, we're going to introduce a special liquid. It's called liquid nitrogen.

C: Nitrogen is an atom that makes up about 70% of the air we breathe. So what state is it in? [Get answer from crowd.] Right, gas. And how are the nitrogen molecules moving? [Get answer.] Quickly and spreading out.

D: Water is a liquid at room temperature but nitrogen is a gas at room temperature. We however, have nitrogen in its liquid state. Given what we've learned today, what do you think the temperature of liquid nitrogen is? [Get answers. Hint: Is it warmer or colder than room temperature]

A: Right, liquid nitrogen is very cold, much colder than even the coldest place on earth. It's at -321 degrees Fahrenheit or as scientists would say, -196 degrees Celsius. Since liquid nitrogen is so cold, it will freeze most of the things we place into it.

B: Therefore, liquid nitrogen is a very dangerous substance, so we're going to ask you to keep a safe distance. We're going to wear special protection to keep us safe. [point out safety equipment as you put it on]

[Use cryogenic gloves and safety goggles as LN2 is a dangerous material. Make sure no students get too close.]

{Liquid nitrogen demonstrations}

A: (Balloon demo)
[Pour a pool of LN2 into a Styrofoam cooler. Place a balloon in the cooler and ask what the class what they think will happen. Then show the shrunken balloon. As it warms, it will expand. Describe this observation as the liquid nitrogen taking away heat from the gas in the balloon, and explain what is happening to the movement of the atoms in the balloon inside the LN and as it comes out.]

B: (Racquetball demo)
[Pour a pool of LN2 into a Styrofoam cooler. Place a rubber racquetball in the cooler and let it sit for ~15 minutes *This must be done when entering the classroom* The rubber ball will sit while the other demos are conducted. Explain that the rubber ball has been sitting in the LN since the beginning. During the racquetball demo, demonstrate how a

normal racquetball bounces, ask the students what they think will happen if the ball is frozen in LN2. *Make sure there is enough space in the room that the frozen ball is thrown in a clear area on the floor away from students.*]

C: (Flower demo)
[Hit a normal flower on the desk and describe its response. Soak a flower in LN2 and hit it against the desk, shattering it. Explain that the water inside the flower freezes into ice, which expands, breaking the cells inside the flower, making it brittle]

D: (Ice cream)
[Others should make the ice cream while it's being explained. The liquid nitrogen is being vaporized as soon as it comes in contact with the air that is much warmer than –196C. Explain that steam is invisible, but the fog that they see is the condensed water vapor in the air. Explain how the LN makes the ice cream.]

Note: In your explanations of the liquid nitrogen experiments that you perform, please refer to the introduction and background material presented earlier in the presentation. Sticking with the same vocabulary and referring back will help reinforce the information that was given in the beginning.