Amgen Award for Science Teaching EXCELLENCE

2008
Winning Lesson Plan from San Juan, Puerto Rico

Dry Ice Activities

by Alexandra Rodriguez Negron

Commonwealth Parkville School

Subject: Properties and Applications of Solid Carbon Dioxide

Grade Level: 10

Duration: Two to three class periods

Overview and Purpose

This lesson plan is a guided exploration into the properties of dry ice. When experimenting with the dry ice students can learn about its chemical and physical properties. Then comparisons can be made to other known substances. Students are able to observe phenomena that can only be explained with kinetic molecular theory and the intermolecular attractions in carbon dioxide. This gives students the opportunity to experience for themselves the theories that are being discussed in the classroom.

Innovation

This lesson plan came about from true scientific inquiry. The classroom I create for my students is one where they feel very comfortable in asking questions about the science we are discussing or the science in their everyday lives. One day a student asked me about the properties of dry ice and why it was called that way. We took some time in class to talk about it and I told them that we could experiment with it if we could find out where they sell it in Puerto Rico. The very next day one of my students came by with a cooler full of dry ice. We spent that day in full scientific exploration. It was amazing to see how creative they were in designing experiments to test the properties of dry ice. Since then I have incorporated this activity as part of my regular lessons. The procedure below is a summary of some of the activities that can be done as demonstrations or guided inquiry. As a rule I always allow my students to openly explore and experiment with the dry ice given any materials they can safely use. If they do not propose some of the activities below then I suggest them, although this rarely happens. When students are allowed free range to question, investigate and explore you will be amazed at what they come up with.

Unit Description and Goals

This lesson plan is part of the States of Matter unit. We start off by discussing the different types of compounds (polar, nonpolar and ionic) and how they are attracted to each other. These intermolecular attractions account for many of the properties of different substances and what is their slate of matter at standard temperature and pressure. The goals of the unit are:

1. For students to describe the motion of particles according to kinetic molecular theory.
2. For students to identify the types of intermolecular attractions.
3. For students to interpret phase changes and state properties relative to the kinetic energy and intermolecular attraction of the particles.
4. For students to apply this knowledge to real life situations.

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Educational Standards

This lesson plan addresses the national science education standards. The national standards are more complete than the Puerto Rico state standards for science so they are the ones we follow at my school. The science content standards emphasize the structure and properties of matter and understanding the nature of scientific experimentation. These standards are met in this lesson plan. Some of the most important educational standards that this lesson plan addresses are:

1. Teaching science through inquiry based activities.
2. Meeting the interest, understanding and experiences of students.
3. Working with other groups across grade levels.
4. Acquiring skills to become independent inquires about the world.
5. Have students participate fully in their learning.

Objectives

1. For students to relate the pressure and temperature with phase changes.
2. For students to understand the effect of intermolecular attractions on the physical state of a substance.
3. For students to differentiate between the phase changes using kinetic molecular theory.
4. For students to develop their skills of scientific inquiry and experimentation.

Materials

Announce this activity to the students a couple of days in advance. The student lab groups should come up with some experiments that they want to perform and bring in their necessary additional materials for these tests.

Solid carbon dioxide	Pliers	Candle
Tongs	Scissors	Tape
Goggles	Spatula	Mortar and pestle
Assortment of beakers	Ziploc bag	Student obtained materials
Thermometer	100ml Graduated cylinder	Plastic cups
Disposable pipets	Universal indicator	Assorted beverages

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Procedures

1. This activity (as any science activity) starts with a discussion of lab safety rules. The students need to understand how to handle dry ice safely and well as review any other routine class room rules.
2. The first period of this activity will be open for student designed experiments. Students are allowed to perform only the experiments that the teacher has pre-approved. Any new idea needs to be consulted with the instructor before proceeding. For each activity the lab group must turn in their procedure, materials and results of the experiments.
3. The second period will be used to share the results from the different groups. Each lab group must prepare to reproduce their experiments as demonstrations for the whole class. As a class we will come to conclusions on the different experiments that are presented.
4. The third period can be used to perform any activity that a student has not already presented. Below are examples of activities/demonstrations. For each activity have students write their observations of your procedure, and answer the questions that follow each activity.

Safety

Always be careful and use tongs or gloves when handling dry ice because it is so cold it will harm your skin on prolonged contact. All students need to wear goggles and aprons at all times.

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Procedures (Cont'd)

1. **Observing Sublimation:** Using gloves or tongs, take a section of dry ice back to your lab area. Observe the vapor trails leaving the dry ice. Crush the dry ice into finer particles and observe.
   - Does the piece of carbon dioxide shiver?
   - Do you see any liquid carbon dioxide?
2. **Rapid Sublimation:** Place a couple of pieces of carbon dioxide into a 250rnl beaker half filled with water. Observe. Take another 250ml beaker fill it half way with water and heat the water to at least 25 degrees above room temperature. Place the same amount of carbon dioxide in this beaker that you placed in the previous beaker. Observe.
   - Why did the solid carbon dioxide sublime more rapidly in the water than in the air?
   - Why did the solid carbon dioxide sublime more rapidly in the warm water than in the cold water?
3. **Combustion:** Tape a candle to the bottom of a beaker and light it. Place various pieces of dry ice into the beaker of warm water from the previous step. When you have a good cloud of carbon dioxide gas going, carefully pour it into the beaker with the candle in it and observe. Be careful not to pour any of the water in the beaker.
   - Why does the candle go out when the carbon dioxide is poured on it?
4. **Mass of a Gas:** Take a plastic Ziploc bag place a piece or two of dry ice in the bag, press out all the air and seal it shut. Weigh the Ziploc bag and dry ice together, Observe the bag for 2-3 minutes until it is inflated with carbon dioxide. Open the bag press out all the gas and then immediately reweigh the bag.
   - How did the mass change? Why?
5. **Acidity**: Take a graduated cylinder and fill it with water to the 95ml mark. Place 10 drops of universal indicator in the water and stir. Carbon dioxide reacts with water to form an acid and this can be observed by the change in the color of the indicator we used. Place a piece of dry ice in the cylinder and observe.
   - Why does the water change into many different colors?

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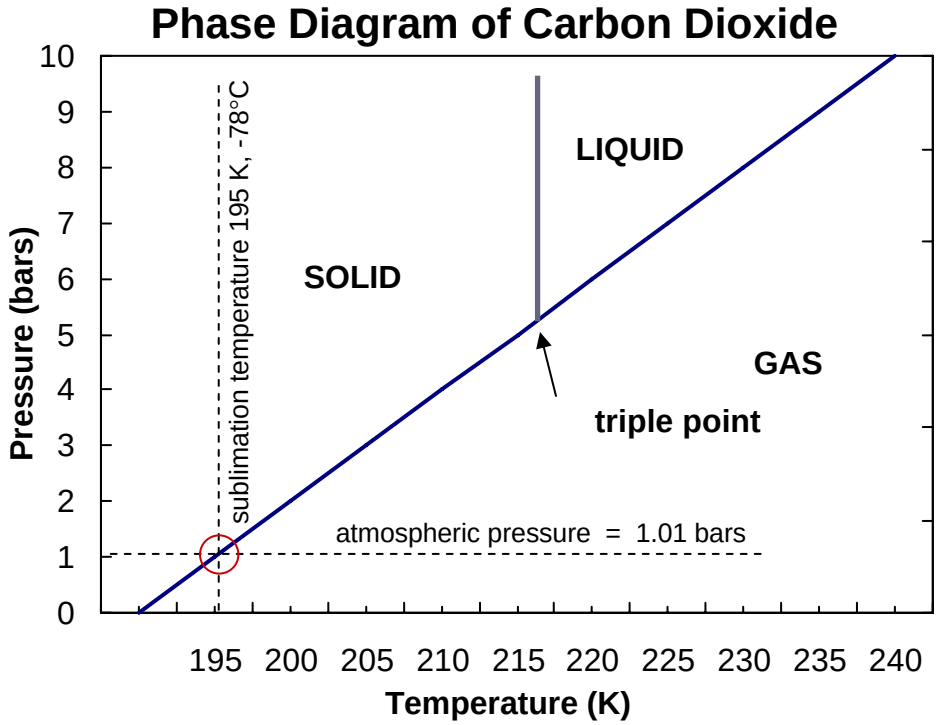
Procedures (Cont'd)

6. **Triple Point (teacher demonstration only):** Crush some dry ice in a beaker with your spatula and transfer the powder to your teacher's class beaker. Your teacher will fill an apparatus that measures the pressure of gasses with pulverized dry ice. Fill approximately one third of the bulb and then bend over the tip to secure it closed. Observe the apparatus carefully since as the pressure builds inside the carbon dioxide will begin to melt rather than sublime. At this point you will be observing the triple point of carbon dioxide. It is very difficult to maintain these conditions so the liquid carbon dioxide may begin to boil as the temperature increases. If you observe this, immediately release the pressure. If the pressure is not released in time the bulb may burst so be careful.
   - Why is liquid carbon dioxide not normally observed at room temperature?
   - Using the phase diagram provided, state what should have been the temperature and pressure at the moment you observed the triple point.



Procedures (Cont'd)

7. **Other:** If you wish you can get a drink from the cafeteria and place some dry ice pellets inside. Remember the gaseous carbon dioxide will not do you any harm but the pellet is extremely cold so you must avoid having direct contact with it.

Other Activities

1. Have students prepare to run this same inquiry activity with other students in the school. Your students will be paired up and assigned a group of visiting students. They will be in charge of communicating safety rules to their group and leading the inquiry activities. At the end of the experience they will write a report on the experience, how it helped them to better understand the material and what they learned from their group.
2. Students can research uses of dry ice to share with classmates during this activity. After the students have explored the properties of dry ice they can come up with a creative way of using dry ice that has not been discussed. They would need to explain the science behind their application of dry ice and why it is useful.