

**Dry Ice Cream!**

**Lesson Type**: Module

**Target Grade**: Elementary School

**Author**: Jerry Lung

**Semester**: Spring 2014

**Brief Overview**

This lesson is a module based lesson intertwining states of matter and food. Central to the discussion is dry ice, whose properties we will attempt to elucidate – it is an extremely cold solid at room temperature, and it participates in a special phase change called sublimation. After which, we may indulge in some treats created using the one and only aforementioned phenomena.

**Teaching Goals**

* The three states of matter and how they transform to each other
* Dry Ice and its properties
* How dry ice affects the phase changes in the food

**Agenda**

* Warm up on states of matter and phase transitions, drawing from every day examples.
* Introduce the dry ice and demonstrate its properties
* Make fun foods with dry ice!

**Lesson Introduction**

* Ask the students about the three (main) phases of matter, and the common phase transitions – ask them about everyday examples they can think of, and supply your own.
* Solid, liquid, gas: should be straightforward to name examples of these…
* Melting (ice to water, candle to wax, butter), Freezing (Water to Ice, snow, icicles, fat when you refrigerate it solidifies (ask them if they’ve ever bought a rotisserie chicken refrigerated it, and examined the solid fat on the bottom of the tray)), Evaporation (boiling water starts to lessen in volume, puddles dry up), and Condensation (cold drink causes water droplets to appear on the outside of the glass!)

**------**

**Module 1: Dry Ice**

**Introduction**

This module will explore what dry ice is, its properties, where it fits into in the traditional phases of matter model.

**Materials**

* Dry ice – only small chunklets/pellets will be used
* 1 big group
* Bowl – filled with water.
* Balloon

**Material to Teach**

* Explain what dry ice is. Teach the kids about dry ice. Ask them what they know about it. Guide them to the realization that dry ice is an anomaly – solid carbon dioxide, -78.5 degrees Celcius or -109.3 degrees Fahrenheit.
* Sublimation: We want to introduce transitions that happen between solid and gas, but handwave over the details that go into it. Teach that these changes happen, albeit rarely, without the details such as pressure, etc**. Under rare conditions, solids can turn to gas and gas can turn to solid, bypassing liquid.** These solids have to be prepared under special conditions, and will turn straight to gas.
* Relate this to what dry ice should be doing at room temperature. It’s “melting”! Show them by blowing on a pellet (your hot breadth will speed up its sublimation).

**Procedure for each Module**

We’ll do some activities with the dry ice that demonstrate its properties. There shall be one designated dry ice handler, who will be outfitted with the warm gloves. No one else shall handle the ice.

**\*\*\*\*EMPHASIZE SAFETY AT THIS POINT!!! BEFORE THE LESSON BEGINS, LET STUDENTS KNOW THAT DRY ICE IS DANGEROUS. FROSTBITE! MAKE THEM PROMISE TO NOT TOUCH IT WITHOUT PERMISSION, AND ESPECIALLY NOT TO EAT IT. TANTALIZE THEM WITH THE PROMISE OF TREATS AT THE END IF THEY BEHAVE.\*\*\*\***

**To do before lesson starts**

Have a mentor start preparing the crushed dry ice for Module 2. See #2 in Module 2’s procedure below. Have another prepare the ice cream mix (unless your group determines beforehand to let the students help – this is a stylistic choice). The rest who are not dry ice handlers should run security, making sure no one contacts dry ice.

**Start of lesson:**

1. Handler will put some ice in the palm of their glove. Demonstrate its coldness to the kids through how the handler must keep the ice moving to prevent frostbite. Tell them that its -78.5 degrees Celsius/ -100 F. Ask them to name cold objects, and try to give them relative temperatures. In Fahrenheit: boiling water is 212, room temp is 70, ice freezes at 32, and dry ice is -109. Make them see the temperature difference between being able to freeze ice and being outside in bathing suits, and then double that, is the difference between ice and dry ice’s temperatures.
2. Place a piece of ice on the table, and push it around. It will glide around effortlessly. Take great care in not contacting any kid, and not letting any kid contact it.
3. It might start to “smoke/melt” (breathe/exhale onto it) ask them why that is. They should understand that something so cold, in room temperature, should naturally start to change phase. Help them see that it’s like an ice cube melting at room temperature. Ask them whether an ice cube melts faster on a hot day or cold.
4. Ask if they think that putting the ice into a colder environment will always make it sublime slower. This is NOT true in the case of the liquid water! Liquid water is obviously a little cold, but it makes the ice sublime much faster because the rate of heat transfer in liquids is way higher. This is why on a cold day, air feels chilly, but getting into a body of water feels REALLY chilly. This transitions into the next activity…
5. Ask them what happens when you put ice in water. The objective here is that the water cools, but the ice also warms – the two *equilibrate* (use mentor skills to explain this balancing/transferring concept in simple terms!) their temperatures. Ask them what would happen if you put dry ice in water? **Split the kids up into smaller groups, give each group a plastic cup full of water, and drop 1-2 pellets of dry ice into it!** Make them see that the dry ice will warm and SUBLIME instead of becoming liquid; the goal is to connect it back to the previous module. They got lectured on sublimation without knowing what it actually is, so now you can demonstrate it. *Connect to #4 by noting how much more it smokes than when at room temperature, which should be the same temperature as the water!*
6. To ram home sublimation, stress that solid CO2 turns into gas CO2 at room temperatures. Blow up one balloon using regular air, and ask the kids what kind of air is inside the balloon (a mixture of carbon dioxide, oxygen, nitrogen, etc.). Carefully, with two mentors working together, put some dry ice in another balloon and tie it up. While it inflates due to sublimation, ask the students what kind of air is inside this one (should be all carbon dio). It will take 10~15 minutes to inflate, so speed things up by putting the balloon in water and blow on it to introduce some more heat. Compare vs a balloon blown up regularly – it will be heavier and sink faster due to CO2 being heavier. Beware that the balloon will blow up at some point, so watch out for that.

**Notes for Mentors**

* SAFETY FIRST. Do not let the kids handle it. Mentors must use gloves when handling it.
* WHILE YOU ARE DOING THIS LESSON, START CRUSHING THE DRY ICE INTO POWDER/SMALL PEBBLE SIZE. See #2 in Module 2’s procedure.

------

**Module 2: Ice Cream**

**Materials**

* Dry ice – should be most of the 5 lbs leftover from previous module
* 1 Big Bowl
* 1 big wooden spoon
* 1 pint heavy cream
* 1 pint half-and-half
* 2 teaspoons vanilla extract
* 1/8 (a pinch) teaspoon salt
* **Per kid: 1 plastic spoon, 1 sandwich size Ziploc brand baggie**
* Optional: Chocolate syrup if chocolate ice cream is desired (site-specific determination)
* Optional: sprinkles, ice cream decor

**Material to Teach**

* Keep in mind the properties of dry ice we’ve just outlined before. It’s *very* cold, and turns to carbon dioxide. Show the students how these properties come into play when we add dry ice to ice cream mix.

**Procedure for each Module**

1. For time’s sake, during the previous module have a team member prepare the groups’ bowls by mixing the ice cream mix ingredients. (Unless you think the students would derive some pleasure from doing so themselves!).
2. **At the same time, make sure the dry ice is crushed into small pieces. Accomplish this by placing the big blocks into the gallon Ziploc bag. Drop it onto a hard surface/ground to break into pellets, and further crush using a hard mallet-type object like the wooden spoon, books, water bottles, etc. Ideally you want a POWDER, SAND, SMALL PEBBLES ON THE RIVERSHORE size at the end.**
3. Portion out the ice cream mix into as many sandwich sized Ziploc brand baggies as there are students, leave none in the bowl. Have the students write their names on their baggies.
4. Wipe the bowl clean if desired, but not necessary. Pour the crushed dry ice into the bowl.
5. Assess your site’s situation: if all the baggies can not fit into the bowl with the dry ice, then split up the process into 2 or more groups – the freezing will not take long, so it will not matter. Proceed by fitting as many bags as you can into the bowl, PACK the dry ice around the bags and bury them well (use the wooden spoon to stir things around). Keep an eye on the ice cream, they will freeze up in a matter of minutes, the kids will be able to observe the change as it happens. Demonstrate to them using a convenient bag, showing them the stages of the freezing.
6. **When the ice cream is rock-hard and extremely cold, you know it’s done. Remove all the bags, BUT DO NOT LET THE STUDENTS EAT YET. It is important to LET THE ICE CREAM WARM BACK UP to a more suitable temperature and consistency. If you have additional groups to run, have them do so at this time. Use your BEST JUDGEMENT on if it’s safe to consume or to wait.**
7. Serve, enjoy and start Module 3 while snacking.

**Notes for Mentors**

* SAFETY FIRST. Do not let the kids handle dry ice. Mentors must use gloves when handling it. Only mentors should be placing the baggies into the ice, and removing them after finishing.
* Again, MAKE SURE YOU WAIT after mixing to eat. Take care not to contact the dry ice with any food directly, as it is not food grade.



* The gas that you see coming off of the dry ice is actually *not* CO2. CO2 is invisible, but there is water vapor in the air that forms a *cloud* due to the coldness of the CO2 coming off.

**\*\*\*CLEAN-UP: YOU MAY PLAY WITH THE DRY ICE A LITTLE BIT MORE TO SEE THE REACTION, IT WILL BE INTERESTING, BUT AFTERWARDS DO NOT DISPOSE OF THE DRY ICE AT THE SCHOOL. BRING BACK IN YOUR CONTAINER IF YOU CAN AND WE WILL TAKE CARE OF IT IN BECHTEL.**

**Module 3: Semester Wrap-up**

* The structuring of this section is up to each individual site. However, this lesson plan provides a suggestion on how to go about the wrap-up process

**Intro (5-10 min):**

* Start off by writing out all the lessons done throughout the semester on the board to give the kids (and mentors) a refresher on what all we’ve done over the semester

-See if students can remember what we did for each lesson - something they enjoyed or something they learned!

-**Sticky Notes:** Have students write down, on a sticky note, words or a drawing that describes what an engineer or scientist is (or does). Bring these sticky notes back to us!!

The goal is to see if students have a better understanding of what scientists and engineers do. Hopefully they have learned that being a scientist or engineer is fun, rewarding, not weird or impossible, and within their reach!

**Favorites (10-15 min):**

* What were some of the kids’ favorite lessons and activities?

**(site leaders should take note!)**

* What’d they like so much about those particular lessons?
* What’d you learn this semester?
* Bonding/ ask about kids’ lives/ ask about us as college students/ “ask me anything!”
* Make sure to give closure, tell the kids you aren’t coming back, but BEAM will be back in the Fall!

**List of Elementary Lessons:**

1. **Marshmallow Catapults**
2. **Spaghetti Bridges**
3. **Telegraphs**
4. **Circulatory System**
5. **Rollercoasters**
6. **Joints in the Body**
7. **Heat Chemistry**
8. **Egg Drop**
9. **Final Project Lessons**

**Summary Materials Table**

|  |  |  |  |
| --- | --- | --- | --- |
| **Material** | **Amount Total** | **Expected $$** | **Vendor (or online link)** |
| **DRY ICE** | **4 pounds** |  |  |
| **Cotton/wool gloves** | **1 pair total, 2 if cost permits** |  |  |
| **Big Bowl** | **1** |  |  |
| **Big wooden cooking spoon** | **1** |  |  |
| **Ziploc baggie, sandwich size** | **One for every kid** | **+ extras** |  |
| **Plastic spoon** | **One for every kid** | **+ extras** |  |
| **Heavy cream** | **1 pint** |  |  |
| **Half-n-half** | **1 pint** |  |  |
| **sugar** | **¾ cup** |  |  |
| **Vanilla extract** | **3 tsp** |  |  |
| **Salt** | **1/8 tsp** |  |  |
| **Napkins** | **To your heart’s content** |  |  |
| **Balloons** | **3~5** |  |  |
| **Sharpie** | **1~2** |  |  |
| **Gallon size Ziploc bag** | **4** |  |  |