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Liquid Nitrogen Demonstrations

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Sources for Liquid Nitrogen

(all sources have been contacted and are willing to sell to teachers who have their own dewar)

Wilson Welding & Medical Gases ($3.95/liter)
(248) 751-7400
Warren, MI

(248) 334-1299
2451 Dixie Hwy, Waterford, MI 48328

(586) 598-9020
46025 N Gratiot Ave, Macomb, MI 48042

P K Supply Co. (~$2.00/liter)
(248) 548-6626
1820 E 9 Mile Rd, Hazel Park, MI 48030

Welding Metals, Inc. (~$2.00/liter)
(248) 585-0480
1604 E 14 Mile Rd., Madison Heights, MI

Superior Welding Supplies, Inc.
(313) 846-5900
15225 Joy Rd, Detroit, MI 48228

AGA Gas, Inc. (~ $1/liter)
(800) 242-4427
Multiple locations (Novi, Grand Rapids, Lansing, Adrian)
(616) 241-6736
1225 Buchanan Ave SW, Grand Rapids, MI 49507
(517) 394-4660
1320 Keystone Ave, Lansing, MI 48911

Apex Welding Gases & Supplies Inc
(616) 396-1941
715 E Lakewood Blvd, Holland, MI 49424

Purity Cylinder Gases, Inc.
(616) 532-2375
2580 28th St SW, Wyoming, MI 49509

If you need something closer to you, look in the phone book or at http://www.smartpages.com under *Welding Equipment and Supplies* or under *Gas – Industrial and Medical*. Also check dermatologists and large animal veterinarians.

Safety First!

Liquid nitrogen can be obtained from a welding supply or medical gas supply company. See the list provided.

DEWAR FLASKS: You should **not** use liquid nitrogen without the proper container. Dewar flasks consist of two metal or glass bowls separated by a vacuum. Because heat isn't transferred very well through a vacuum, they can keep things cold for a very long time. These can be purchased through your chemical supply company. If you are going to transport the liquid nitrogen, make sure you have a Dewar that has a narrow neck, and secure it safely in your vehicle. The lid should not be threaded as enormous amounts of pressure build up as the liquid vaporizes.

Now as you all know, Nitrogen is about 78% of the volume of the atmosphere and has a boiling temperature of 196.5 degrees below zero Celsius. In plain simple English, **it's cold.**

Safety Issues

Simple rules for handling Liquid Nitrogen: We could say DO NOT LET IT TOUCH SKIN but someone will be a bonehead and do it anyway. The truth of the matter is that the human body is so hot to the Liquid Nitrogen that it will boil in your hand with out any harm to you. However, the instant you contain the liquid Nitrogen, like in a fist, you increase the pressure of the gas trying to escape. The pressure builds up enough to give you a very bad freezer burn. Enough to need medical attention, so take our word for it and don't.

Liquid nitrogen is a dangerous material. The following is an excerpt from the Air Products Nitrogen Material Safety Data Sheet:

> A back of the envelope calculation indicates that the entire contents of a 10 Liter Dewar being spilled in a unventilated 274 square foot room with an 8 foot ceiling would reduce oxygen levels below the 19.5% level where Air Products recommends the use of a respirator. Since most classrooms are larger than this, suffocation does not represent a major danger. When transporting the liquid in a car, however, it is probably a good idea to open a window.
> The possibility of freeze burns represents a much more serious danger and is therefore our first concern. This does not mean that the demonstration itself is dangerous, but it does mean you must be careful.
> Dangers include:
> - Nitrogen can spatter (possibly in eyes) while being poured.
> - Flying chunks of frozen objects could cause eye injury.
> - Students (being children) will want to reach out and touch nitrogen or other cold objects.
>
> As mentioned above, contact with nitrogen can cause tissue damage, and this must be prevented.
>
> Therefore, specific safety precautions should include:
> - Teachers must stress to their students the importance of not touching frozen objects or nitrogen.
> - Wear goggles whenever pouring or dumping nitrogen. Nitrogen can spatter into the eyes, and potentially blinding pieces of frozen things can fly around when we drop it.
> - Use a glove and / or tongs to handle any object going into or out of nitrogen and to carry the nitrogen Dewar.
> - Teachers should familiarize themselves with the following first aid instructions (excerpted from the Air Products Nitrogen Material Safety Data Sheet) for cryogenic freeze burns just in case the worst happens:
>   - If cryogenic liquid or cold boil off contacts a worker's skin or eyes, frozen tissues should be flooded or soaked with tepid water (105-115°F, 41-46°C). DO NOT USE HOT WATER.
>   - Cryogenic burns, which result in blistering or deeper tissue freezing, should be seen promptly by a physician.
> - Remember to stress the importance of not touching liquid nitrogen or frozen objects.

What to do with Liquid Nitrogen:

The most important thing is……

Ice Cream!!

We use a very simple recipe of

- 1 pint Half and Half
- ½ cup sugar
- 1 container of egg beaters (binder for the ice cream)
- 1-2 tsp. Vanilla
- ½ cup of chocolate chips, or berries, or other fun stuff

you will also need a Stainless Steel mixing bowl
Wooden mixing spoon
Gloves
A big sink or level place

Keep all ingredients cold! Make sure the sugar is dissolved in the cream base. Pour the cream base into a large metal bowl. Add one to two liters of liquid nitrogen and stir vigorously. When the cream has thickened, add the chocolate chips or fruit to mixture and more liquid nitrogen, if necessary. Continue to stir until the nitrogen has evaporated (the fog has disappeared).

This recipe does not keep well and is best if consumed immediately. If it begins to melt before everyone is served, simply add more liquid nitrogen and stir. Use ice cream cones (or bowls with spoons) for serving.

Here are some recipes and directions from the Internet.

http://webs.wichita.edu/facsme/nitro/cream.htm
http://www.polsci.wvu.edu/Henry/Icecream/Icecream.html

What else to do with Liquid Nitrogen:

Of course, there are other, less fattening things to do with Liquid Nitrogen. Here are just a few. (Do an Internet search for Liquid Nitrogen Demonstrations, or get the Lee Marek book to find more.)

The two main things LN_2 is good for are freezing and expansion as it vaporizes. Both are fun, yet can be hazardous. BE CAREFUL

1. **Freeze and crush anything**.
   - fresh flowers
   - rubber tubing
   - hollow balls- racquet balls work better than felt covered tennis balls
   - food- oranges, sausages, bananas (make good hammers when frozen)

2. **Thermal expansion/compression**. (Available from Fisher Science Education)
   - Metal ball fits through a metal ring at room temperature.
   - Submerge the ring, and the ball no longer fits.

3. **Thermostat**. (Compound Bar or bimetallic strip is available from Fisher Science Education)
   - The bimetallic strip has two different metals on either side of the strip.
   - The differing expansion coefficients will cause the metal to bend when heated or cooled.
   - You can heat the strip in a Bunsen burner, and it will bend the OPPOSITE way in the liquid nitrogen! (very cool)
   - The thermostat in your house uses a bimetallic strip that is coiled up to fit in a small box.

4. **Show changes in elasticity due to temperature**.
   - rubber bands that snap apart
   - superballs that don't bounce
   - let them warm up to room temperature and show the return of these physical properties
   - Start a show by sticking one end of very flexible tubing (e.g., latex or tygon) down into a Dewar; the heat of the tubing will cause LN2 to spray out the other end of the tubing, and you can direct the spray at the audience. After the submerged end of the tubing is completely frozen (and the spraying stops), remove from the dewar and whack the frozen end on a table; watch it break into pieces.

5. **Show gas laws and phase changes**.
   - Freeze an air filled balloon and show volume change as the gas contracts, and expands when returned to room temperature.
   - Blow up a balloon and slip the end of the balloon over the open end of a test tube, and place the closed end in LN2. Your breath in the balloon will slowly liquefy (10-15 minutes). When the balloon is completely deflated, lift the test tube out of the Dewar and the audience can see your liquefied breath in the test tube. The tube will frost up, but you can wipe the frost off with your fingers. Rest the test tube in a beaker, and as time passes, the balloon will inflate again.
   - Fill a film canister, tennis ball can, or Pringles can and put the lid on. As the nitrogen vaporizes, the increased volume will pop the lid off (sometimes quite violently, so point it away from yourself and students. Biology teachers make good targets!!) You can do the same thing with a balloon. Use a funnel to introduce the liquid.
   - Soak a piece of chalk in the nitrogen. Place the chalk on a smooth, flat surface, and it will "float" as the gas evaporates out of the pores in the chalk. Good for "air hockey."
   - Freeze a water balloon, then peel off the balloon. Because of water's high specific heat, the outer layer of ice will be surrounding a pocket of liquid water.
   - Put some liquid nitrogen into a whistling teakettle. As the liquid vaporizes, the kettle will sing to you.
   - Do the egg in the bottle trick, but instead of burning paper in the bottle, submerge the bottle in liquid nitrogen
   - If you put about 10 ml of LN2 into a styrofoam cup into a bell vacuum you can see solid nitrogen. The crystallization "puffs" up very quickly. It is cool to be able to see N2 as a solid, liquid and a gas.
   - Place a constant-volume pressure apparatus in a flame or hot water and then LN2.
   - Cap a syringe at room temperature and then submerge part of it in the LN2.

6. **Kinetics stuff**
   - Get $NO_2 \leftrightarrow N_2O_4$ demonstration tubes (available from Flinn). Place one in warm water and one in LN_2 to show the effects of temperature on the equilibrium
   - Place one glowstick in hot (not boiling) water and an identical glowstick in LN_2 to observe the dependence of reaction rate on temperature.

7. **Liquefy oxygen and show its paramagnetic properties**.
   - You need a strong (neodymium) magnet for this
   - You can levitate the oxygen droplets in a strong horseshoe magnet (talk to your physics teacher)

8. **Wart removal simulation**.
   - Doctors will cryogenically remove warts by freezing the tissue to make it rigid, and then it will blister and fall off, or it can be scraped away.
   - Moisten a paper towel with water and then ball up the paper towel and drop it in the liquid nitrogen.
   - Pull the "wart" out with tongs, shake off excess nitrogen, and then crush it.

9. **Why cryonics can't work**. (great for bio teachers too!)
   - Make a "cell" by filling a helium-quality balloon with water. Remove the air bubble.
   - Completely submerge the cell, and talk about cryonic freezing of humans while it freezes.
   - When you hear a 'pop,' pull out the cell to show the expansion of water and the hole in the membrane.
   - You can peel off the balloon and show the encapsulated water in the middle of the ice 'egg'.

10. **Exploding Suds**.
    - Fill a temperature-resistant narrow-mouthed bottle with a soap solution (warm water is best)
    - Slowly add liquid nitrogen ("smoke" starts to appear)
    - Shake container (keep the mouth vertical!), and suds explode out of the top as the nitrogen is warmed and bubbles through the soap solution
    - NOTE: this is best on carpet (just like carpet shampoo!); it can be slippery on tile.

11. **Magic stuff**.
    - Make mist by pouring water into the liquid nitrogen. Hot water works even better.
    - Inhale some of the vapors and exhale "smoke."
    - Soak a graham cracker or marshmallow in the liquid, then eat it. Exhale the "smoke." (careful with this one…shake off excess liquid nitrogen first!)
    - Put a sausage or hot dog into one of the fingers of a glove. Put the glove on with one of your fingers folded into your palm so that the sausage looks like your own finger. Soak your "finger" in the nitrogen. Crush the "finger" with a hammer. BE CAREFUL TO HIT THE RIGHT FINGER!!
    - "Fry" an egg using LN2. Crack an egg into a frying pan. Pour LN2 over the egg. It turns into a "fried egg"! When it warms up again, it becomes an uncooked egg once more.

- Place an egg (raw & in shell) in container and cover with liquid nitrogen. after the nitrogen has evaporated, take the egg out smash it with a hammer, it appears to be hard-boiled. As it cools it returns to "raw" white and yolk.
- Inhale the fumes, then exhale to everyone's amazement.
- Break a light bulb, put the filament into liquid nitrogen and turn it on.

12. **Physics stuff**.
    - Put a pinhole in a ping-pong ball at an angle. Soak the ball in the liquid nitrogen until the nitrogen has time to fill the ball (hold it under for 30 seconds or so.) When the ball is put on a flat surface, the gas will escape from the hole as the liquid vaporizes. The ball will spin as the gas escapes the tangential hole.
    - If you have access to super conducting materials, you can place the material under liquid nitrogen and float a magnet over the super conducting material.
    - Drop a neodymium magnet through a metal tube. The strong magnet induces a current in the metal tube that provides and electromotive force (EMF) on the magnet, causing it to fall slower. Pour liquid nitrogen into the tube to cool it and pass the magnet through again. It will fall at a much slower rate due to the decreased resistance (which means increased current, therefore increase force) of the metal at low temperature.
    - Take a 'ringshooter' (used to demonstrate Lenz's Law by placing an aluminum ring around an AC electromagnet [made by wrapping wire around a long thin iron core - typically 15-20 cm high and 3 cm in diameter]). Demonstrate that the Al ring will jump into the air (a split Al ring and a non-conducting ring will not move) from the magnetic repulsion. Now chill the Al ring in LN2. Repeat the demonstration and the ring will jump MUCH higher (since its resistance decreases substantially at -196^{o}C).

13. **Dangerous stuff - Do this outside with plenty of room between you and the demonstration**.
    - Get a heavy-duty plastic 50-gallon garbage can.
    - Put about ½ liter of liquid nitrogen into a 2-liter pop bottle and cap it.
    - Very quickly, put the capped bottle down and invert the garbage can over it.
    - RUN!!!!! The liquid will vaporize; the gas will expand and blow the bottle into bits, which will project the garbage can up to 30 feet.

    ….and one last idea that I got from a professor friend of mine. (disclaimer- I have never tried this and do not know how well it works.)

    Freeze a can of foamy aerosol (shaving cream, whipped cream) for a good long time. Carefully remove the aluminum can while the substance is still frozen (I don't know how, I was just told to do it). Take the frozen cylinder of cream and let it out in a wide open space on a nice sunny day (not in a colleague's car!!) and it will expand before your eyes. Be prepared to clean it up!!