



LN2 Explosion

Amount of time Demo takes: 15 minutes

Don't try this at home!

Lesson's Big Idea

- Gases take up 1000x more space than liquids! When LN2 boils in the closed bottle it can't expand; instead, the pressure rises inside the bottle until the plastic gives way in an explosive fashion.
- Shows the volatility of a sealed, pressurized container.

Materials

- 2 L soda bottle (after experimentation, we've found Sprite bottles to be fairly effective)
- ¼ roll of duct or gorilla tape (We recommend original strength Duck tape)
- 1 Lead Brick
- Funnel (we prefer to use a metal funnel but any kind will work)
- Safety goggles (2) and pair of cryo-gloves (2)
- BRUTE 32 gallon garbage can filled ¾ with water (optional: with several water balloons or ping pong balls floating on top)
- LN2 dewar, mostly full.

SAFETY!

- Always wear eye protection, gloves, and long pants when using LN2.
- Once the bottle is capped you are essentially holding a pressure bomb. Cap the bottle, drop it in, and move away from the blast zone.

Background Information

- Since liquid Nitrogen boils at the extremely low temperature of -321 degrees F, it boils immediately when exposed to any outdoor or room temperatures.
- When poured into the Sprite bottle, the LN2 starts boiling and forming Nitrogen gas. Once the bottle is closed and set into the garbage can full

of water, the bottle is quickly gaining internal pressure. The bottle isn't able to contain the pressure of the Nitrogen gas, and therefore explodes to release all of the gas and relieve pressure.

Setup Instructions

1. This demonstration requires two Mind Trekkers!
2. Gather all supplies and place garbage can in an open area with good viewing potential and the possibility of keeping people 10-15m away from the garbage can.
3. Drain all the soda from the 2L bottle. Try to get all the liquid and foam out of the bottle as possible.
4. Wrap tape around the bottle. Make sure that there is absolutely no part of the bottle showing. Use the tape to secure the bottom of the bottle to the lead brick. Two strips both the long ways and short ways going under the brick and up the sides of the bottle works the best.
 - a. Note: There are different methods to tape the bottle to the brick, each producing a different effect. Experiment!
5. Keep all safety gear and materials near the garbage can until time of explosion.

Instructional Procedure

1. Gather a large crowd around the can, keeping them about 10-15 meters away from it.
2. Ask the crowd the assessment questions before starting.
3. It's best to have a third person explaining what's going on, while you are doing it:
 - a. Fill a 2L bottle $\frac{1}{3}$ with LN2.
 - b. Seal the bottle (with LN2 still boiling inside of it).
 - c. Sink the bottle to the bottom of the can.
 - d. Hopefully, after 30 seconds - 1 minute, the bottle will rupture releasing the pressure.

Tips & Tricks

- Use normal strength duct tape to tape the bottle. Heavy-duty duct tape has caused issues in the past. We use the original strength, Duck Tape. Patterned duct tape also tends to cause problems because it is thicker. Use only one type of duct tape on the bottle to keep uniform strength around the bottle.

- Everyone has a variation of the way they tape the bottle and each method produces a different type of explosion (height/sound/burst diameter). This can be something you experiment with.
 - Jannah's style (for a split down the center, about 30-40 seconds until it goes off, 20 gallons of water out):
 - Take 12" strips of duct tape and wrap them around the bottle horizontally working your way from the bottom to the top (you don't have to duct tape the very bottom of the bottle).
 - Take an 18" strip of duct tape, place the brick on it on the center of the strip, tape the bottle to the top of the brick by sticking the rest of the length of tape to the bottle vertically. Three strips running around the brick the short way, one the long way.
 - Take the roll of duct tape and wrap it continuously horizontally around the bottle to lock the vertical strips in place again working from bottom to top.
- We used to use Diet Coke bottles but Coke has recently made the walls thinner and the caps shorter so we were popping the caps off of the bottle instead of ripping the bottle in half which was leading to very weak explosions.
- Always carry the taped bottle and brick by holding the brick or the bottle can tear off.
- If you happen to have a dud, you will likely see bubbles coming from the garbage can (a sign that gaseous Nitrogen is coming out of the bottle). Stay back until the bubbling has died down as sometime the explosion will still go off depending on where the bottle cracked.
- Don't rush putting the cap on the bottle. The pressure won't build up inside the bottle until the cap is sealed. Try to get it straight and tight.
- Should the bottle come off the brick BEFORE you are able to put it in the garbage can, immediately remove the cap from the bottle and throw it on the ground. Removing the cap will let the pressure escape and allow the LN2 to evaporate without building up pressure.
- For an added dramatic effect, add ping pong balls to the garbage can (before or immediately following putting the filled and capped bottle in). These will fly into the air with the water when the explosion goes off.
- Be mindful of where you are setting off the explosion. If it is on concrete, you may bust your garbage cans sooner. If the ground is wet or

very soft under the garbage can you are bound to leave a nice divot.

- Get the old Brute 32 gallon trash cans (without the grooves that make pulling out bags easier). All of the grooves in the newer designs are all weak points in the garbage cans which results in splitting them after just a few explosions. If you have an older garbage can without these grooves, you may be able to get up to 50 explosions per garbage can!

Assessment Questions

1. At what temperature does LN2 boil?
 - a. -321 degrees F
2. What happens when a liquid boils?
 - a. It turns into a gas and takes up more volume
3. What happens when a weak container tries to contain an enormous amount of pressure?
 - a. BOOM

Real World Applications & Careers

- Liquid Nitrogen is used for a variety of purposes such as storing samples in labs or even freezing off warts!
- LN2 is also used as a coolant in computers!
- LN2 is now a trend in the culinary field. More restaurants are using LN2 for cooking and visual effects.
- **Careers:**
 - Medical Lab Scientist
 - Biologist
 - Genetic Scientist
 - Biomedical Engineer
 - Chef

Clean Up

- Be sure to remove all sensitive equipment from the area as soon as the explosion is done (LN2 dewar, safety gear, funnel, etc.).
- Dewars should be brought up to room temperature before being stored for long periods of time
- The garbage can should be dumped out and dried before being stacked and put away. **It is extremely hard to pull apart garbage cans or buckets that were stacked while wet.**
- Pick up any pieces of the exploded bottle in the explosion area. The

broken bottles can be thrown away.

Related Next Generation Science Standards

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- 9-12
 - HS-PS3 Energy