Mr. Balmer **Name: ______________________________ Pd:___**

Liquid Nitrogen Demos

Purpose- Using liquid nitrogen, you will be able to apply the kinetic molecular theory, Boyles' Law, Charles' Law, Amontons' Law, etc. to predict/explain what will happen in each of the demonstrations.

Hazards-

~Liquid nitrogen can build up so much pressure inside a sealed container, that it could cause the container to explode. Liquid nitrogen should be stored in a Dewar flask.

~Liquid nitrogen boils at -196 ˚C (-321˚F). This cold temperature can quickly freeze your skin.

~Breathing lots of nitrogen could interfere with your ability to breathe oxygen gas, which could cause suffocation. Normal atmospheric oxygen levels are between 20.8 and 21% (confined). The minimum oxygen levels permitted before symptoms may occur is 19.5% (confined).

~Liquid nitrogen has an expansion factor of 1:696 (environmental). This means that 10L of liquid nitrogen would produce 6,960L (246ft^3) of nitrogen gas. If the original oxygen concentration in the room is 21%, then 6,960L of nitrogen would drop a 97,440L room (3,441ft^3) to an oxygen concentration of 19.5%. **With 10-ft ceilings, you should use 10L of liquid nitrogen in a room no smaller than 344 square feet. To determine the volume of a room needed for a certain amount of liquid nitrogen you can use the equation below, where R stands for the room's volume in liters and N stands for the volume of liquid nitrogen in liters.**

$$\frac{0.21\,(R - 696N)}{R} = 0.195$$

or

R (in liters) = 9,744 x N (in liters)

R (in cubic feet) = 343.7 x N (in liters)

Resources

"Confined or Enclosed Spaces and Other Dangerous Atmospheres: Oxygen-Deficient or Oxygen-Enriched Atmospheres." *Shipyard Employment ETool*. OSHA, n.d. Web. 07 Aug. 2014. <https://www.osha.gov/SLTC/etools/shipyard/shiprepair/confinedspace/oxygendeficient.html>.

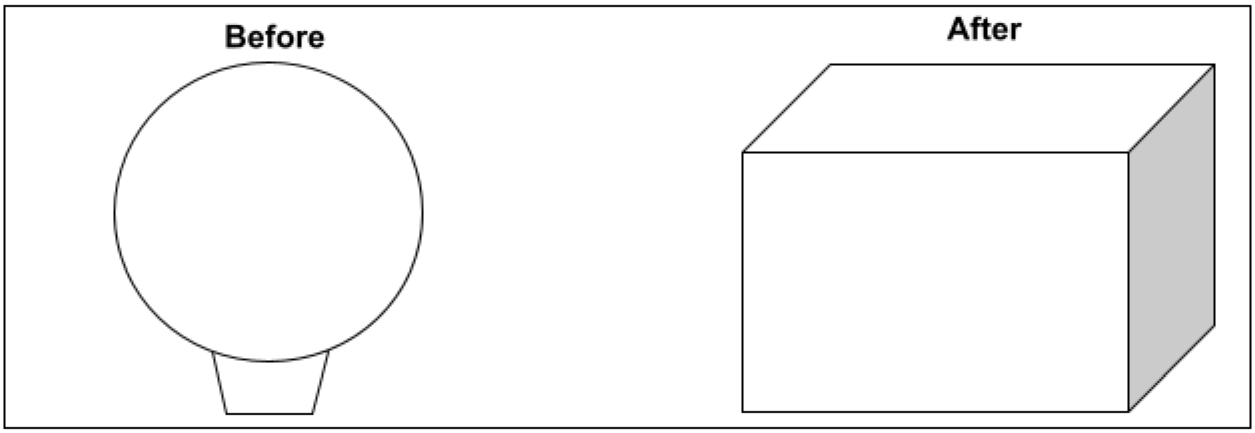
"Environmental Health and Safety: Liquid Nitrogen Guidelines." *Research and Graduate Studies*. Utah State University, n.d. Web. 07 Aug. 2014. <http://rgs.usu.edu/ehs/htm/programs-and-services/laboratory-safety/liquid-nitrogen-guidelines>.

"Frostbite Theater." *Science Education*. Jefferson Lab, n.d. Web. 08 Aug. 2014. <http://education.jlab.org/frost/>.

Procedure- You will write a hypothesis for each demonstration using the kinetic molecular theory (KMT) and/or your gas laws as supporting evidence. You will also draw a picture to represent the behavior of the molecules in each demonstration.

- **Demo #1: Balloons in a Box**
  Hypothesis: How many balloons will I be able to fit into the box that contains liquid nitrogen and why?

  Observations:



- **Demo #2A: Pressure of a sealed flask lowered into liquid nitrogen**
  Hypothesis: What will happen to the pressure inside a sealed Erlenmeyer flask when it is lowered into liquid nitrogen? Why?

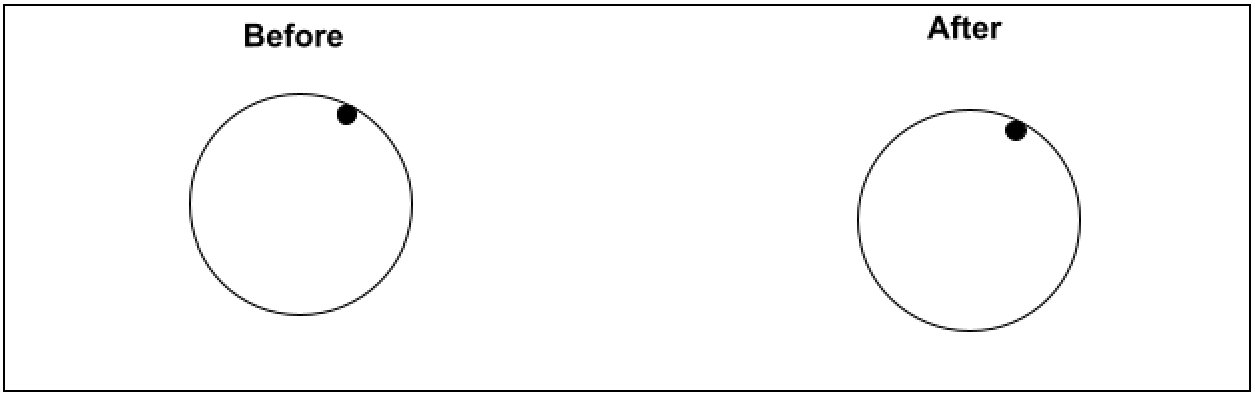
- **Demo #2: Water balloon on a flask lowered into liquid nitrogen**
  Hypothesis: What will happen to the water balloon that is sitting on top of the Erlenmeyer flask when the flask is placed in liquid nitrogen? Why?

  Observations:

- **Demo #3A: Liquid Nitrogen in a Tea Kettle**
  Hypothesis: What will happen when liquid nitrogen is poured into a tea kettle? Why?

- **Demo #3: Ping Pong Ball**
  Hypothesis: What will happen to a ping pong ball that has a hole in its side when it is transferred from the liquid nitrogen to the table top? Why?

  Observations:

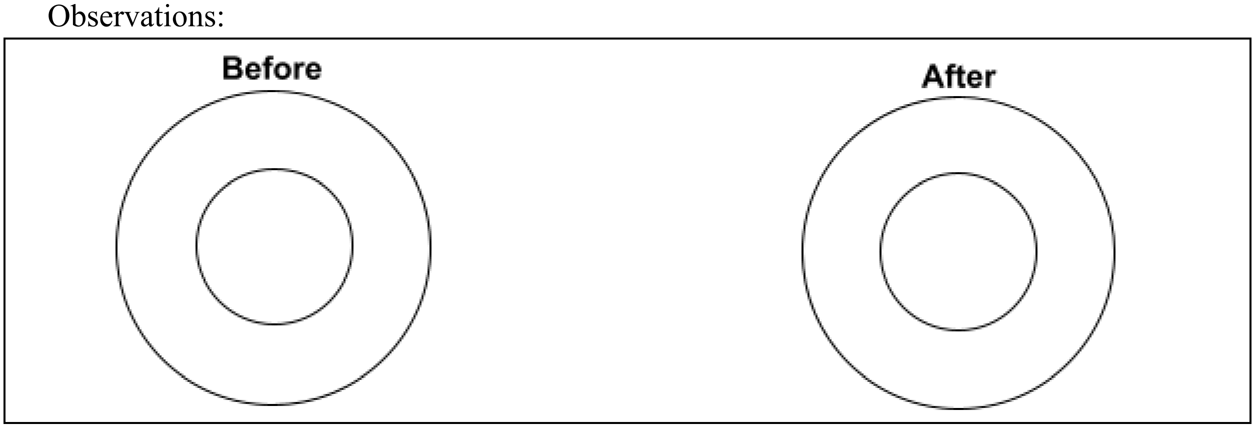


- **Demo #4: Racquet Ball**

Racquet balls are made out of a polymer called isoprene. Isoprene has a glass transition temperature (T_g) around -80ºC. Below the glass transition temperature a polymer is brittle and acts like a glass. Above the glass transition temperature a polymer is flexible and acts like rubber.

Hypothesis: What will happen to a racket ball when it is placed in liquid nitrogen and then bounced? Why? Use the information above for support.

Observations:



Optional Demonstrations

- **Liquid Oxygen**
  Hypothesis: Oxygen has a boiling point of -183˚C. What will happen to oxygen gas when it is placed in liquid nitrogen? Why?

- **Cold Pennies: Does Age Really Matter**
  Pennies made before 1982 were made out of solid copper. Pennies made after 1982 have a zinc core beneath a thin layer of copper. Your teacher will demonstrate the malleability of each metal by hitting the pennies with a hammer. Your teacher will then cool a pre-1982 penny and a post-1982 penny in liquid nitrogen. Afterwards, both pennies will be hit with a hammer to look for differences in malleability when cold.

Conclusion: Tell me something "NU"

New: What new modifications would you make to the experiment to study new independent variables or some other real-life application of this experiment? **Be specific**. Adding more repeated trials doesn't count as a modification. You cannot say you wouldn't make any changes. Don't be vague by using words like **change, different, etc.** without giving extra details. If you want to use different materials, give me some **specific examples.**

Uncertain: What concepts from the lab are you still uncertain about? In other words, what questions do you still have after completing the lab? You cannot say that you are uncertain about nothing. If you have no uncertainties, then you can tell me about something you were uncertain about before the lab and which part(s) of the lab/discussion helped to clear up that uncertainty. If this lab was too simple for you, then you can ask me a challenging question related to the lab you wish you **knew** the answer to.