**Lesson Plan** : Gas Laws with Balloons

*This lesson plan is intended to be a guide to see how a demonstration might fit in to the lesson, information wise. This lesson plan does not contain the modes of how to teach, rather a suggested outline of information.*

**Students will:**

* know the relationship between volume and temperature (Charles’ Law)
* know the relationship between volume and pressure (Boyle’s Law)
* know the relationship between volume and moles (Avogadro’s Law)
* calculate changes in volume, temperature, pressure, or moles based on these gas laws

**Background Knowledge Assumed**

* students know how to convert units
* students can manipulate the equation moles = $\frac{mass}{molar mass}$
* students understand the definition of temperature

**Hook**

 The instructor does the demonstration “[Shrink a Balloon](http://sites.jmu.edu/chemdemo/2011/06/14/shrink-a-balloon/)” with a helium filled balloon.

**Lesson**

1. The instructor begins to discuss what went the students saw. The balloon shrank in the liquid nitrogen, and then expanded when at room temperature again. The instructor asks the class in which situation do the helium molecules in the balloon have more energy – at room temperature (25˚C) or in liquid nitrogen (-196˚C)?
*The students should be able to reason that the helium molecules at the higher temperature (room temperature) have more energy based on their understanding of the definition of temperature*
2. The instructor discusses that when molecules have more energy they move more, just like we do when we have more energy.
3. This concept can also be related to how when we’re cold we tend to huddle up; we contract and tend to move less. But when we’re warmer we spread out more; we expand and move more. Gas molecules act the same way with temperature by increasing and decreasing their volume.
4. This relationship between temperature and volume is called Charles’ Law which can be written mathematically as $\frac{V\_{1}}{T\_{1}}$ = $\frac{V\_{2}}{T\_{2}}$ It is pointed out that this only holds for constant pressure and number of moles. When the demo was done the pressure in the room did not change, and the number of moles of helium in the balloon also did not change. It should be noted that temperature must be in Kelvin for these calculations.
5. The instructor asks the students how they think that volume and pressure relate. The instructor can ask students to think about the balloon full of helium. If the instructor presses against the outside of the balloon (decreasing the volume) what happens to the pressure of the balloon?
*The students should be able to reason that the pressure increases.*

This is the reason that if too much force is applied to the balloon, it pops because the pressure is too great. The instructor asks the students to think about if the balloon were bigger (increasing the volume) what would happen to the pressure?
*This is more abstract thinking, but students should be able to think through it and realize that the pressure would decrease because there would be more room for the same amount of gas.*

1. The relationship between volume and pressure is called Boyle’s Law which can be written mathematically as P1V1 = P2V2. It is pointed out that the number of moles of helium in the balloon was held constant and the temperature of the room did not change.
2. The instructor asks the class what would happen if more moles of helium were added to the balloon. What would happen to the volume?
*The students know that when more gas is added to a balloon it gets bigger.*What if moles were removed from the balloon? (The instructor can use an untied balloon that he or she has blown up to show the volume increasing and decreasing.)
*The students know that when gas is released from a balloon it gets smaller.*
3. The relationship between volume and moles is called Avogadro’s Law which can be written mathematically as $\frac{n\_{1}}{V\_{1}}$ = $\frac{n\_{2}}{V\_{2}}$ It is pointed out that the pressure exerted on the balloon remained constant in the room, as well as the temperature of the room.
4. STP is defined as standard temperature and pressure, where the temperature is 0˚C (273K) and the pressure is 1 atm.
5. The instructor can work through Gas Laws Examples (see below) with students.

Gas Laws Examples

1. A 0.538 mol sample of propane gas occupies a volume of 7.89L at 156˚C.
2. Assuming that the pressure remains constant, what temperature (in ˚C) is needed to reduce the volume to 2.50L?
3. Which gas law is this?
4. At STP a 16.8g sample of chlorine gas has a volume of 5.3L.
5. How much does a 8.9L sample of chlorine gas weigh?
6. Which gas law is this?
7. A 0.50 mol sample of carbon dioxide occupies 243cm3 at 0.972 atm.
8. What is the volume (in L) of the sample at 0.685 atm? Assume that the temperature remains constant.
9. Which gas law is this?