Lesson Title	Where My Peeps At?
Length of Lesson	1 hour 15 min
Created By	Chris Ruhs
Subject	Chemistry
Grade Level	10-12th Grade
State Standards	Chemistry I: 10 a,b
DOK Level	DOK 2-3
DOK Application	Students observe, illustrate, and think deeply about Boyle's and Charles's laws.
National Standards	B (Physical Science)
Graduate Research Element	Understanding of Boyle's and Charles's Laws underpins the dynamics of VOCs, is significant for GCMS work, and is generally needed for preparing chemical reactions.

Student Learning Goal:

MS 9-12th Grade:

Chemistry I: 10 (a) Describe a gas, liquid or solid in terms of Kinetic Molecular Theory. *Students described and discussed how particles are given more energy when heated, and have more room to "use their energy" when pressure is lowered.* (b) Describe the relationship among volume, temperature, pressure, and moles using ideal gas laws. *Students will experience and deeply understand Boyle's and Charles's Laws, involving the temperature, pressure, and volume of a constant amounts (change in n = 0) of gases.*

National Science Education Standards of Content 9-12:

B: Physical Science: Structure and Properties of Matter. *The concepts in this lesson plan are underpinned by the behavior of gases when temperature or pressure is changed.*

Materials Needed (supplies, hand-outs, resources):

Laboratory worksheet, bell jar with suction pump, balloons, small plastic cups, peeps, Bunsen burner with gas line, beaker of soap water.

Lesson Performance Task/Assessment:

Formative:

1. Short review of Boyle's and Charles's Laws, emphasizing their inverse and direct proportionalities, respectively.

Summative:

1. Place students into groups of two.
2. Hand them the laboratory worksheet (attached).
3. Walk them through the laboratory procedures, allowing them time to complete the entire worksheet (see attached).
    a. Balloon expands when atmospheric pressure is removed

b. Water boils at 50 degrees Celsius when atmospheric pressure is removed
c. A "peep" expands when atmospheric pressure is removed
d. A balloon expands when the gases inside it are heated
e. Bubbles filled with methane gas are ignited, and the resulting gases expand as they are rapidly heated in a fireball

Lesson Relevance to Performance Task and Students:
An abstract and/or mathematical understanding of gas laws is useful for teaching students how to approach word problems relating to gases, however, students may not envision the reality of what these laws signify. This activity-based lesson plan is designed to tie real-world scenarios and laboratory experience into their abstract understanding, so that the understanding is reinforced and robustly integrated.

Anticipatory Set/Capture Interest:
In the review of the gas laws, I had students close their eyes, and I verbally took them on a journey into a submarine down to the Marianas Trench, and then told them that the submarine was not well constructed. Following this I verbally took them on a journey high up in an airplane, and told them that there were leaks in the hulls. Both of these imaginative journeys relate to Boyle's law. I also had the students imagine filling up a hot air balloon, and floating over the country side. (Imagination is one of the most important skills a chemist can have, since the atomic world is largely intangible and invisible.)

Guided Practice:
Review of gas laws.

Independent Practice:
Five laboratory activities, worksheet completion, and drawing of diagrams.

Remediation and/or Enrichment:
Remediation:
Individual IEP, simpler explanations, less demanding drawings.

Enrichment: Discussion of complex situations involving the gas laws.

Check(s) for Understanding:
Describe and give examples for the two gas laws.
When the pressure acting on a gas increases, what happens to its volume?
When the temperature of a gas increases, what happens to its volume?

Closure:
Students come up with five real-world examples for each law, and draw one from each.

Possible Alternate Subject Integrations:

Environmental science: Atmosphere and climate change.

Teacher Notes:
The combination of imagining, group work, hands on activities, watching demonstrations, discussing other possibilities, and drawing and explaining everything was deeply beneficial for students. As much as possible, integrate these different sensory and brain-stimulating techniques.