Lesson Plan for GAS LAWS
Part 1: Simulation

Aim: To explore the relationship between volume, pressure, and temperature with respect to the behavior of gasses in the gas laws

Agenda: (This lesson may need two class periods!)

- **Gas Laws Science Detective's Notebook and simulation (45 minutes)**
- **Wrap Up (5 minutes)**

Materials:

- **Computers**
- **Science Detective's Notebook #3: Gas Laws**

Lesson Procedure:

Distribute computers:

Go to: **www.create.nyu.edu/mm** and navigate to the Gas Laws simulation

Simulation Activity:

Students complete the Science Detective's Notebook while working through the Gas Laws simulation

Entry 1: Make Observations and propose a Hypothesis

Students read short online comic narrative called "The Case of The Busted Basketball."

Students read a story about how a basketball changed overnight and begin to think about the relationships between temperature volume and pressure.

Students find clues in the story and generate a hypothesis to explain what has happened to the ball using the variables of temperature, pressure, and volume.

Entry 2: Explore A Model to Test Your Hypothesis

Students work through online tutorial and explore the gas laws simulation.

The gas laws simulation brings together temperature, volume and pressure and helps us see how these factors are related.

Students identify the variable in the simulation and sketch a graph showing the relationship between any two of the three variables of temperature, volume and pressure.

Entry 3: Make Generalizations To Generate A Law

Students generate a law about the relationship between the independent and dependent variables they have explored.

Entry 4: Synthesize What You Learned

Students read about Guillaume Amontons and the need for accurate thermometers and think about the connection between KMT and the gas laws. Students connect what they observed in the simulation to "The Case of the Busted Basketball."

Entry 5: Explore Another Gas Law - Boyle's Law
Entry 6: Explore Another Gas Law - Charles' Law

Students use the simulation to explore Boyle's and Charles' Laws, record data, and draw graphs based on the modeling of each law in the simulation.

Entry 7: Apply Your New Understanding to "The Case of the Busted Basketball"

Students bring together what they have learned from the narrative and simulation.

Entry 8: Put it All Together: The Combined Gas Law

Students are shown how the Combined Gas Law can be derived from Amontons', Boyle's and Charles' Laws. Students work step-by-step through a problem and then solve some additional problems.

Lesson Plan for GAS LAWS
Part 2: Lab/Demo

Aim: Understand how pressure, temperature and volume are all related according to the Combined Gas Law.

Agenda:

- **Do It Now** (5 minutes)
- **Demonstration Analogy** (5 minutes)
- **Combined Gas Law:** notes and problem set (20 minutes)
- **Erlenmeyer flask and egg activity (**15 minutes)
- **Wrap Up**
- **Something Extra:** As a car owner, what concerns arise with tires in the winter? What concerns arise in the summer? Use your knowledge of the gas laws to explain this phenomenon

Materials:

- **Gas Laws Lab Notebook**
- **Balloon**
- **Egg**
- **Flask**
- **Hot Water Bath**
- **Cold Water Bath**

Entry 1: Do It Now

Review Of Charles', Boyle's, and Amontons' Laws

See Gas Laws Lab Notebook pages 27-32 for the review questions.

Demonstration Analogy (Optional):

Use 8 volunteers and put them in a square. (4 volunteers are inside the square [they are the gas molecules], 4 make the walls, and the teacher pushes them in) As the wall goes in, what happens to the gas molecules? Do they like this?

Entry 2: Lab/Demo

Content for discussion:

The Gas Laws: Amontons', Boyle's and Charles's Law
You may want to pull up the simulation to review Amtonton's, Charles' and Boyle's Laws:

Amontons' Law: Relates temperature and pressure at constant volume, as would occur with a rigid container. **Temperature** – independent/ **Pressure** – dependent/ **Volume** – constant (see lab/demo)

Boyle's Law: Relates pressure and volume at constant temperature.
Pressure – independent / **Volume** – dependent / **Temperature** – constant

Demonstration, Squeeze a partly inflated balloon…"as I apply pressure to the outside of the balloon, what is happening to the volume of the balloon?" "What happens to the pressure inside the balloon? Why?"(The gas molecules are hitting the walls more quickly and it increases the internal pressure).

Draw a graph to show the relationship.

Charles's Law: Relates temperature and volume at constant pressure
Temperature – *independent* / **Volume** – *dependent* / **Pressure** – constant
Draw a graph similar to this: (perhaps the students can suggest what the graph might look like?)

This demonstration was inspired by:
Adcock, L.A. (1998). The egg in the bottle revisited: Air pressure and Amontons' Law (Charles' Law). *J. Chem. Ed. 75*, 1567-1568.

This demonstration/lab allows you to explore Amontons' Law with students in a different way than they did with Gaby's basketball simulation. This can be done as a lab or a demonstration.

Summary of Gas Laws and Simulations

Review how the simulations and concepts are related

	Diffusion	***KMT***	***Gas Laws***
Variables	Temperature, atomic mass & time for diffusion	Pressure & temperature	Pressure, temperature, & volume
Examples	Tea in hot water; oxygen in bloodstream; gases used in WWI trenches	Boiling water & the lid popping off	Balloon rising with temperature; forcing gases into a smaller container
Simulation Narrative	Punk & Popcorn	Deserted Dessert	Busted Basketball
Lab/Demo	Food coloring & agar plate	Heating & cooling balloon on flask	Erlenmeyer flask & egg

Wrap Up

Entry 3: Extension Activity

See Student Handbook for questions.