Lab 9: Explorations of Gas Laws

In this lab, we will explore:

1. A simple model of single-particle "projectile" motion
2. A model of an ideal gas as a collection of non-interacting particles

The goal is to understand both how such simulations are constructed, and how such simulations can be the basis of *virtual laboratories.* We will use computation to reduce many years of physical experiments into efficient numerical investigations. You will be expected to write up a lab report on the gas law explorations that include a complete set of experiments. You may choose to do all of the work yourself (pledged) or you may work with others to "divide and conquer" the several experiments (pledged, with declaration of your working partners).

I. Modeling simple projectile motion: class exercise with discussion

1. Download and open in NetLogo:

http://www.shodor.org/~rpanoff/CS150/NetLogoModels/SimpleProjectileMotion.nlogo

2. Follow class discussion noting:
   a. How is "muzzle velocity" broken into X and Y components
   b. How is vertical speed changed at each time step
   c. How does the projectile know when it collides to "bounce"

II. Modeling Ideal Gas as a collection of non-interacting particles

1. Download and open in NetLogo:

http://www.shodor.org/~rpanoff/CS150/NetLogoModels/IdealGasLaw.nlogo

2. Follow initial class discussion for "model check out" and inspection

3. Either by yourself or in organized groups, perform the following experiments, collecting the data in well-organized tables in your notebooks (each experiment should be repeated for each observation multiple times or by multiple persons, comparing results and estimating errors):

   a. Set initial-number to 100. Find the equilibrium Pressure for 10 values of Volume (adjusting initial-wall-position from 8 to 96, for instance). What do you observe about the Temperature for each run? Graph P(V)

   b. Set initial-wall-position to 30. Find the equilibrium Pressure for 10 values of N from 40 to 400. What do you observe about the Temperature for each run? Graph P(N). Repeat the experiment but set initial-wall-position to 50. What do you observe about the Temperature? How does P(N) change?

c. Set initial-wall-position to 8. Set initial-number to 100. Find the equilibrium Pressure. Then increase the Volume and adjust the Number of particles to keep the Pressure constant. Do this for 10 different values of the Volume. Graph V(N)

d. Set initial-wall-position to 30. Set initial-number to 100. What is the equilibrium Temperature and Pressure? Now "warm" the walls to get 10 different values of T and for each find the equilibrium Pressure. Graph P(T). Repeat the experiment but set initial-wall-position to 50. How does P(T) change?

e. Set initial-wall-position to 30. Set initial-number to 100. What is the equilibrium Temperature and Pressure? Increase Volume and adjust the Temperature to keep the Pressure constant. Repeat this for 10 different values of Volume. Graph V(T)

f. Set initial-wall-position to 30, set initial-number to 40. What is the equilibrium Temperature and Pressure? Increase N, and adjust the Temperature to keep the Pressure constant. Repeat this for 10 values of N from 40 to 400. Graph T(N).

4. Which of the above 6 graphs are LINEAR (implying proportion)? Which modifications to the NON-LINEAR graphs could you make to result in a LINEAR graph? (graph the modifications to show this).

5. What single equation summarizes all 6 experiments? Show this explicitly in your discussion. Compare what you learned from these 6 experiments to the statements made in the Gas Laws handout from class.