

Physics Exploration Homework Supplement P110-15

Ideal Gas Simulation and Boyle's Law

Today you will work on a three part experiment to investigate some of the variables in the Ideal Gas Law.

PART ONE:

In this part of the assignment you will be playing with a computer simulation written by the University of Colorado, Boulder. The simulation's name is "Gas Properties". If you want to, you can download the program and complete the following sections at home. The simulation can be found at:

<http://phet.colorado.edu/en/simulation/gas-properties>

First we will be investigating what happens when you add or remove heat from a fixed volume of ideal gas.

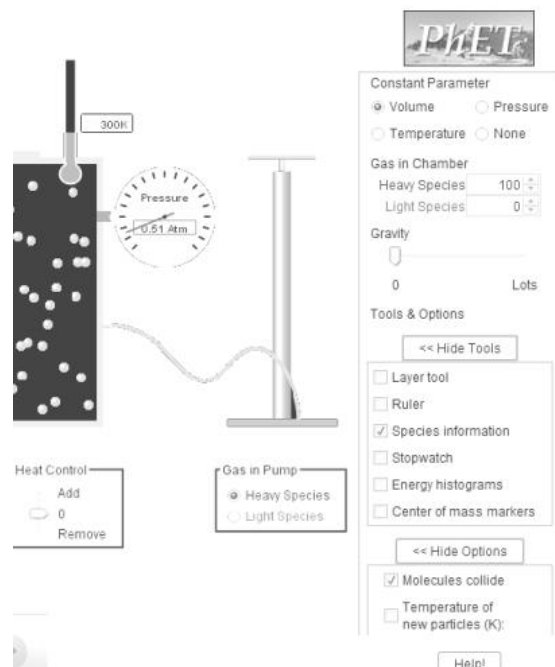
1. Set the following parameters on the simulation.

- Constant Parameter – Volume
- Heavy Species – 100
- Light Species – 0
- Gravity – 0
- \checkmark Species information
- \checkmark Molecules collide

2. Starting at 100 ° K adjust the temperature of the gas by increments of 100 ° K until you reach 1000 ° K. (You can do this by adding or removing heat from the system with the "Heat Control" icon.) On a separate sheet of paper record the pressure for each increment of 100 ° K and then plot the Pressure versus Temperature for this system of gas molecules .

3. What type of plot did you find? (Exponential, sinusoidal, linear, logarithmic,.. etc.)

4. Is this what you expected? Explain your answer.



PART TWO:

Next we will be investigating what happens to the pressure in an ideal system when you hold the temperature constant , but increase the number of molecules.

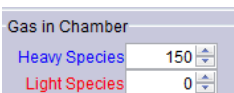
5. Press the "RESET" button at the bottom right of the simulation and then set the following parameters for this simulation (See next page).

Physics Exploration Homework Supplement P110-15

Ideal Gas Simulation and Boyle's Law

• Constant Parameter –Temperature	• $\sqrt{\quad}$ Species information
• Heavy Species – 50	• $\sqrt{\quad}$ Molecules collide
• Light Species – 0	• $\sqrt{\quad}$ Temperature of New Particles (K): 300

6. Starting at 50, adjust the number of gas molecules in the system by increments of 50 until you reach 500 particles in the system. (You can do this by adding particles in the Heavy Species label of the “Gas in Chamber” section of the simulation (See diagram below. You should also see a corresponding increase in the “Species Information” panel.).



On a separate sheet of paper record the pressure for each increment of 50 added particles. Then plot the Pressure versus the Number of Particles for this system at each increment of 50 molecules.

7. What type of plot did you find? (Exponential, sinusoidal, linear, logarithmic,.. etc.)
8. Is this what you expected? Explain your answer. (What assumption about the volume was inherent in this simulation? Is this assumption reasonable over a small range of pressures?)

PART THREE:

In this final section of this assignment sheet we will investigate Boyle's Law. We will be measuring the pressure in a 60ml syringe as a function of the syringe's volume.

9. Boyle's Law basically states that the Pressure x Volume= Constant. What other physical parameters would you expect to be “constant” or nearly constant so that this relationship holds? (For example in this experiment we are relying on the fact that if we advance the piston a specific distance the volume of the syringe is changing by a known amount. If that was NOT true, we could not easily measure the volume change.)
10. Turn the valve lever on the end of the syringe to let air into the syringe pressure sensor system. (See diagram on table.)
11. Press on the button on the side of the clamp handle to side it forward (or backward) so that the piston of the syringe creates a volume of 50 ml in the syringe cylinder.
12. Rotate the lever on the valve at the bottom of the syringe so that air can NOT leave the syringe pressure sensor system.(See diagram on the table.)
13. The computer will display the pressure in the syringe at this volume. Record this pressure and volume.
14. Press the clamp's handle once so that it advances forward one notch. (This should be a change of approximately 2 or 3 ml.) Record the new volume and pressure. (Read the volume directly off the scale of the syringe.)
15. Repeat step 6 until you have recorded data down to a volume of 20 ml.
16. Plot the Pressure Vs. 1/Volume.
17. What type of plot do you expect? (Exponential, linear, quadratic, logarithmic, sinusoidal ...etc.)
18. The graph you plotted does it match your expectations? Justify your answer. (Consider the assumptions you made in question 9.)