

Purpose: To study the ideal gas law and apply the first law of thermodynamics to analyze behavior of gas. Go to <http://phet.colorado.edu/en/simulation/gas-properties> and run the simulation

Procedure**PART A: THE NATURE OF THE IDEAL GAS LAW**

1: What happens to the pressure in the chamber if you heat the gas?

2: What happens to the temperature in the chamber if you compress the gas?

3: Locate the "Constant Parameter" section of the on-screen control panel. Lock the temperature. Use "Scubie" to slowly compress the gas. What happens to temperature, and what action is taken (by the simulation) to maintain constant temperature?

4: Lock the pressure. (Doing so releases the lock on temperature.) Add heat. What happens to pressure, and what action is taken (by the simulation) to maintain constant pressure?

PART B: Kinetic Molecular Theory and the First Law of Thermodynamics

For each of the following four steps record the average pressure (in atm) and the volume

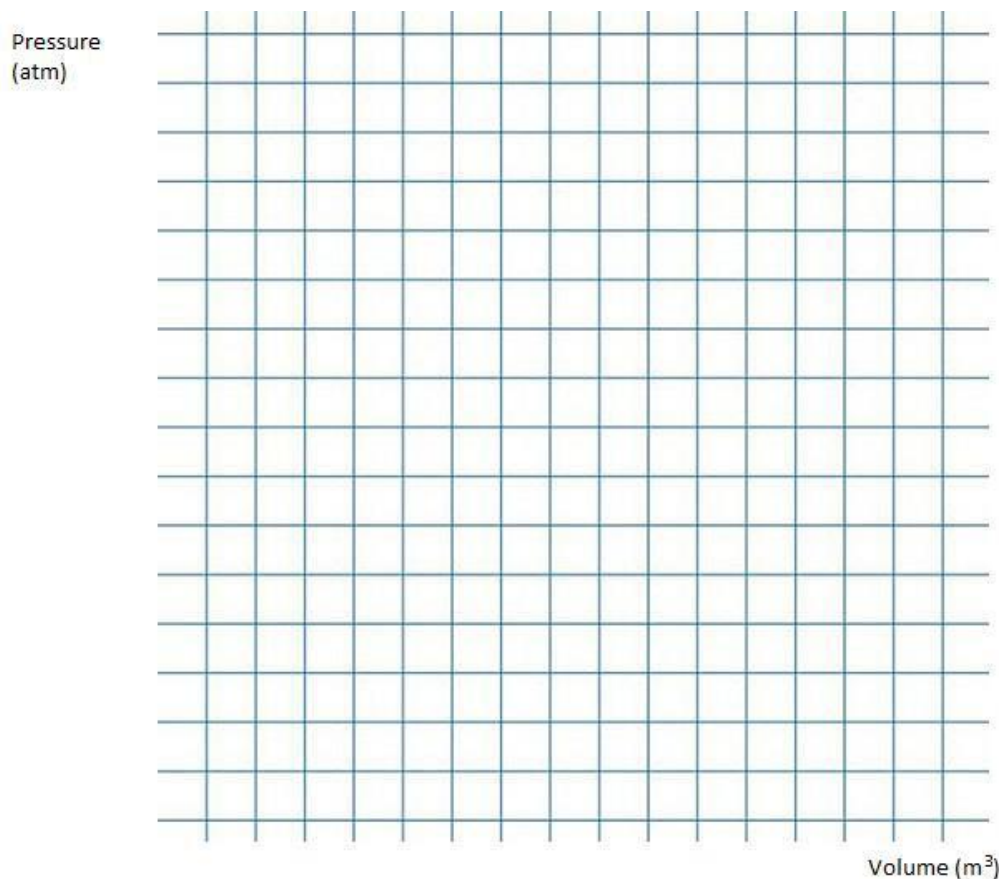
Table of Pressure and Volume for each step

Step	1	2	3	4
Pressure (atm)				
Volume (m ³)				

1. Add 300 molecules of the heavy species to the chamber and let the temperature and pressure come to equilibrium.
 - a. Using Avogadro's number express the amount of gas in terms of moles.
 - b. Calculate the internal energy (U) of the heavy oxygen gas in joules .
 - c. The container is rectangular in shape with an area of $2.81 \times 10^{-17} \text{ m}^2$. Using the ruler tool (in measurement tools) measure the interior length of the container and report measurement in meters.
Length: _____ m
 - d. Calculate the volume of the container (in m³)
 - e. Create different volumes and record the average pressure (in atm) and the volume in the table above for step 1.

2. Under constant parameters click Pressure so that pressure remains constant, then use the heat control to SLOWLY add heat to increase the temperature to 428 K.
- Measure the new length of the chamber and calculate the new interior volume of the gas (average pressure should be the same as it was in step 1). Record these values in the table on the first page for step 2.
 - Was work done _____ on or _____ by the gas or _____ neither? (place a check mark before your choice)
 - Calculate the work done, W_o (Note: convert pressure to pascals)
 - Calculate the final internal energy (U) of the gas, U_f
 - Calculate the change in internal energy of the gas, ΔU (U_i was calculated in step 1.b.)
 - Was heat _____ add or _____ removed from the gas? (place a check mark before your choice)
 - Using the 1st Law of Thermodynamics, calculate the amount of heat (Q) added
 - What type of thermodynamics process that took place during this step?
3. Under constant parameters click volume and reset gas. Add 300 heavy species to chamber and increase the temperature again to 428 K.
- After the gas reaches equilibrium, record the average pressure (in atm, volume is the same as in part 1) and record the pressure and volume in the table on the first page for step 3.
 - Was work done _____ on or _____ by the gas or _____ neither? (place a check mark before your choice)
 - Calculate W_o
 - Calculate ΔU
 - Was heat _____ add or _____ removed from the gas _____ neither? (place a check mark before your choice)
 - Calculate Q
 - What type of thermodynamics process that took place during this step?

4. Reset the container and click none under constant parameter, add 300 heavy species to the chamber and allow the temperature to reach an equilibrium. Under constant parameters click Temperature and using the ruler tool, expand the chamber so the interior volume is 9.0 nm.
- Calculate ΔU
 - Is heat _____ added or _____ removed from the gas or _____ neither?
 - Was work done _____ on or _____ by the gas or _____ neither?
 - Calculate the new volume of the gas:
 - When the chamber has reached equilibrium:
 - Record the average pressure (in atm):
 - Calculate the volume (in m^3):
 - Record the pressure and volume values above in the table on the first page for step 4.
5. On the graph below generate an appropriate scale based off the pressure and volume data in your table. Then plot and label the points on the graph.

Graph of Pressure vs. Volume

6. Point 1 is the initial point for all trails. Connect point 1 to point 2, point 1 to point 3, and point 1 to point 4 with an arrow showing the direction of the process and being careful to draw straight lines or curves as is dictated by the type of thermodynamic process.

7. Based off the graph above, rank the work done BY the gas from greatest to least for each process. Explain how you used the GRAPH to determine your rankings.
8. Summarize each process. Include in your summary the type of process (isobaric, isovolumetric, isothermic, etc), how the pressure, volume and temperature changed and if this corresponded to work being done on or by the gas, how the internal energy changed, and if heat was added or removed from the gas.
- Process 1 to 2
 - Process 1 to 3
 - Process 1 to 4