

# Ideal Gas Law at Constant Volume (Simulation)

## Purpose:

We will study the behavior of gas and compare with the Ideal Gas Law  $PV=NkT$ .

## Useful Information:

$$1 \text{ atm} \approx 10^5 \text{ Pa}, k = 1.38 \times 10^{-23} \text{ J/K}$$

## Procedure:

1. Google “PhET” and click on the first search result. This should take you to the homepage of the Physics Education Technology. Alternatively you can enter the following address to the web browser directly:  
<http://www.colorado.edu/physics/phet/web-pages/index.html>
2. Click on “Simulations” and then choose from the tabs on the left “Heat & Thermo”. Scroll down to the “Gas Properties” simulation, double click it to start the program.
3. Click on “Measurement Tools” on the right and select “Layer tool”, “Ruler” and “Species information”.
4. Play with the simulation a little to get a feeling of what it does. Note that you can select either heavy or light species of gas from the pump. At the end you can click the “Reset” button at the bottom to start again.

## Constant Volume:

1. Under “Constant Parameter” on the right, select “Volume”. This will keep the size of the box fixed.
2. Pump in some heavy particles. Record the number of heavy particles ( $N_{heavy}$ ) in Table 1 below using the information on the right column of the program. Since there are no light particles, I have put in  $N_{light} = 0$  for you. Fill in the total number of particles  $N_{total} = N_{light} + N_{heavy}$ .
3. Record the temperature and pressure in Table 1 below. Next try different temperature by adding or removing heat to complete the table.

**Table 1**

Heavy Species Only

$N_{light} = 0$	$N_{heavy} =$
$N_{total} =$	
Temperature (K)	Pressure (atm)

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4. Pump in or remove (by opening the lid) some particles (either the light species or the heavy ones). Adjust the temperature in each case and record your results in Table 2 and Table 3 below.

**Table 2**

Mixed Species

$N_{light} =$	$N_{heavy} =$
$N_{total} =$	
Temperature (K)	Pressure (atm)

**Table 3**

Mixed Species

$N_{light} =$	$N_{heavy} =$
$N_{total} =$	
Temperature (K)	Pressure (atm)

5. Repeat the above procedures for Table 4 with both heavy and light particles present, but now with  $N_{total}$  chosen such that it is equal to the  $N_{total}$  of Table 1.

**Table 4**

Mixed species with  $N_{total}$  equal to Table 1.

$N_{light} =$	$N_{heavy} =$
$N_{total} =$	
Temperature (K)	Pressure (atm)

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## Data Analysis:

1. Plot the 4 sets of data on the same  $P$  vs  $T$  graph. Do not forget to write on the graph the units of the  $x$  and  $y$  axes. Label clearly on the graph which line corresponds to each table.
2. Find the slope for each line. What is the unit of the slope?
3. Convert the unit of the slope to  $Pa/K$ , using the fact that  $1 atm \approx 10^5 Pa$ .
4. Use  $PV=NkT$  and the slope to find the volume of the box. Compute the volume four times, once for each table.

## Questions:

1. Are the slopes of Table 1 and Table 4 the same? Can you explain it using the Ideal Gas Law?
2. If I increase  $N_{total}$ , what will happen to the slope of the line?