

Virtual Lab – Kinetic Molecular Theory

Background

Kinetic Molecular Theory is particularly useful for explaining the observed properties of gases, such as the pressure exerted by confined gases as well as gaseous effusion and diffusion. Kinetics is a reference to the motion of molecules, which is most pronounced in the gas phase. Though the name “Kinetic Molecular Theory” sounds quite complex, it is really based on a relatively simple set of assumptions. Molecules confined in the gas phase can be imagined to be independent, randomly moving particles. They undergo frequent collisions with one another, as well as with the walls of the container. The average speed of the molecules is a function of their masses, as well as the temperature.

Purpose

The purpose of this lab is to examine the effect of variables such as volume, temperature and the number of molecules present, and the size of those molecules on other measurable properties such as pressure and the rate of diffusion.

Procedure

Part 1 – Access the Applet

- a. The URL for the applet that we will be using is <https://phet.colorado.edu/en/simulation/gas-properties>
- b. Open the page in your browser. You will probably be asked if you want to run the applet for security reasons. Let the applet run, and take a few minutes “playing around” with it to familiarize you with how it works.

Part 2 – Volume and Pressure

- a. Select the radio button next to “Temperature”, so that temperature is held constant.
- b. Introduce 500 molecules of the “Heavy Species”.
- c. Now, decrease the volume *slowly*, noting the effect that it has on pressure. Record your observations.

Part 3 – Temperature and Pressure

- a. Keeping the existing molecules in the container, maximize the volume of the container then select the radio button next to “Volume”, so that volume is held constant.
- b. Select the “Measurement Tools” for “Species information” and “Energy histograms”. Move them so that you can see both, as well as the gas container.
- c. Slowly increase the temperature. Record your observations of the effect on pressure, as well as the effect on the speed and kinetic energy of the molecules.

Part 4 – Number of molecules and Pressure

- a) Keep the radio button next to Volume selected. Turn off the “Species information” and “Energy histograms”.
- b) Reset the applet so that there are no molecules in the container.
- c) Move the pump handle slowly up and down, noting the effect that the addition of molecules has on pressure, and paying attention to the display of molecular behavior. Record your observations.
- d) Keep the radio button next to V selected. Reset the applet so that there are no molecules in the container.
 - i. Add 500 molecules of the Light Species to the container. Let them disperse through the container, and then record the average pressure.
 - ii. Reset the applet. Add 500 molecules of the Heavy Species to the container. Let them disperse through the container, and then record the average pressure.
 - iii. Reset the applet. Add 250 molecules of EACH species to the container. Let them disperse through the container, and then record the average pressure.

Part 5 – Speed of Molecules and Temperature

- a) Keep the radio button next to Volume selected. Turn off the “Species information” and “Energy histograms”.
- b) Reset the applet so that there are no molecules in the container.
- c) Add 250 molecules of EACH species to the container. Let them disperse through the container.
- d) Select the “Measurement Tools” for “Species information” and “Energy histograms”. Move them so that you can see both, as well as the gas container.
- e) Record the temperature and the average speed of each of the species of molecules

Part 6 – Rate of Diffusion and Temperature

- a) Keep the radio button next to Volume selected.
- b) Reset the applet so that there are no molecules in the container.
- c) Add 500 molecules of the Light Species to the container. Let them disperse through the container.
- d) Add 1 molecule of the heavy species, and observe its ability to diffuse (move through) the other gas.
- e) Increase the temperature. Decrease the temperature. Record your observations on the effect of temperature on the rate of diffusion of the gas.

Kinetic Molecular Theory – Explaining the Behavior of Gases

For each set of observations, provide an explanation of the observation in terms of Kinetic Molecular Theory. In other words, explain what was happening at the molecular level that produced the observed behavior.

Observations	Explanation (Why?)
<i>Part 2 – Volume and Pressure</i>	
<i>Part 3 – Temperature and Pressure</i>	
<i>Part 4c – Number of molecules and Pressure</i>	
<i>Part 4d – Number of molecules and Pressure</i> Pressure created by 500 molecules of the Heavy Species _____ Pressure created by 500 molecules of the Light Species _____ Pressure created by 250 molecules of each (500 total) _____	
<i>Part 5e – Speed and Temperature</i> <div style="text-align: right; margin-right: 100px;">Temperature _____ K</div> Average Speed of Heavy Species _____ m/s Average Speed of Light Species _____ m/s Are all molecules of one type moving at the <u>same</u> speed? _____	
<i>Part 6e – Rate of Diffusion – Effect of Temperature</i>	