Department of Earth & Climate Sciences
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Name____________________

ERTH 260: Laboratory Exercise 5 Key
Understanding the Gas Law
100 points
(Due Friday 2 March 2018)

Download the applet to illustrate the Ideal Gas Law.

- The simulation uses Nitrogen (for the heavy species) and this is a good approximation of the gases in the atmosphere. Oxygen, for example, is about the same size. The simulation is set so that when you "pump in gas" into the given volume, the volume will not change until you request it to change, and the temperature of the gas will be 300K, until you request it to change.
- Pump in enough air so that the gage says 1.00 Atm (it doesn't matter if you are a little off). This will correspond to an internal pressure in the volume of around 1000 mb.
- The temperature of the earth-atmosphere system (explained in class) is around 289K. Click the "Remove" word on the Heat Control at the bottom middle of the applet diagram until the thermometer reads approximately 289K.
- You now have a simulated atmosphere in the volume that generally corresponds to earth conditions, with the exception of the lack of gravity.

1. How does the diagram at this point illustrate that pressure is a function of the collisions between the molecules and the walls of the container? (10 points)

At this point, one can see the activity of the molecules clearly visualized. One can see that the molecules are vibrating, but in moving randomly, they are also colliding and imparting a force to the walls of the chamber (and to one another). That conceptually illustrates pressure, which is a force per unit area.

2. How does the diagram at this point illustrate that temperature is a function of the vibration of the molecules? (10 points)

At this point, one can see the activity of the molecules clearly visualized. One can see that the molecules are vibrating and colliding with the walls of the chamber and one another, causing more vibrations in neighboring molecules. Since the vibrations of molecules is related to temperature, we can see that the diagram illustrates temperature.

3. To test your answer in Lab 4, Question 1, select as the "Constant Parameter" the Temperature, on the radio buttons at upper right. Now gradually

decrease the volume (increase the density of air) just a bit, perhaps 10%, by pressing in on the lever on the left just a bit.

a. What happened to the number and strength of collisions between the molecules and the container walls? (10 points)

As the volume decreases, the density of the air in the chamber increases. The numbers of collisions with the walls of the container increases. Since pressure is a function of the number and strength of these collisions per unit area, the pressure increases.

b. What happens to the pressure, as shown on the schematic barometer? (10 points)

The pressure increases, as anticipated by my answer above.

c. Do the results of this virtual experiment corroborate your answer above? (10 points)

The results in (b) above, corroborates my answer in 1(a) above.

4. To test your answer in Lab 4, Question 2, shut the applet down and restart it (N.B., there is a bug so that if you simply select Reset, the applet does not work correctly. Then rerun the preliminary steps to get the schematic atmosphere in the chamber 289K and at 1 atmosphere. Now select as the "Constant Parameter" the Volume, on the radio buttons at upper right. Now gradually increase the by 100K by clicking the Add button on the Heat Control.

   a. What happened to the number and strength of collisions between the molecules and the container walls? (10 points)

   As the temperature increases, the numbers of collisions with the walls of the container increases. Since pressure is a function of the number and strength of these collisions per unit area, the pressure increases.

   b. What happens to the pressure, as shown on the schematic barometer? (10 points)

   The pressure increases, as anticipated by my answer above.

   c. Do the results of this virtual experiment corroborate your answer above? (10 points)

The results in (b) above, corroborates my answer in 2(a) above.

5. To help you visualize the actual atmosphere, we must include the impact of the acceleration of gravity. Reset the applet and make sure the Constant Parameter is set to None.

   Now move the "Gravity" indicator to the first tick point to the right, which will simulate earth's gravity. Now give the pump just one good push to bring gas into the container. Notice that the experiment keeps the average temperature at nearly 300K.

a. Visually, how does the density of the gas vary from bottom to top of the container? (10 points)

   Visually, the molecules appear more packed (closer together) on average at the bottom of the container.

b. Press the “Measurement Tools” radio button and select “Layer Tool”. Describe how pressure varies with elevation in the container from the bottom to the top? (10 points)

   Pressure is greatest at the bottom of the container and lowest at the top of the container, where it approaches zero.

c. Explain how your answers in (a) and (b) above are consistent with what we observe in the real atmosphere. (5 points)

   In the real atmosphere, pressure and density decrease with height until both are zero beyond the upper limit. Hence, the results I had in (a) and (b) above are consistent with what we see in the real atmosphere.