Student Directions for *Gas Properties* Chemistry

http://phet.colorado.edu/

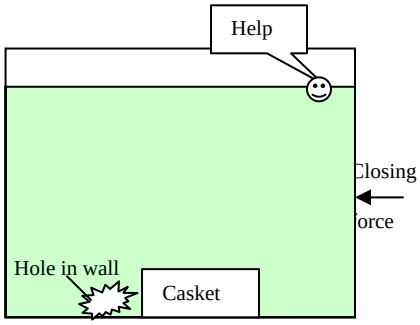
Learning Goals: **Students will be able to:**

- **Describe a molecular model of gas pressure.**
- **Describe what happens to the measurable quantities if changes to a gas system are made.**
- **Make sense of the measurable quantities of gases by analyzing examples of macroscopic *(visible)* things that are similar.**
- **Explain using physics what is happening on a molecular level when changes are made to a gas system.**

1. Design experiments so that you can find all the things that affect pressure, make a table like the one below to summarize your results.

Pressure Model			
What was held constant	What was varied	Pressure change	Explain in terms of KMT

2. One student wrote the following story as a macroscopic analogy for what he thought was happening when a full balloon is opened.



I am an adventurous archeologist trapped in a tomb full of sand. Fortunately, I am on top of the sand and can cry out for help. My trusted aid hears me and knocks a hole into the tomb wall, several feet below.

"This is great, the sand will pour out and I'll be with you soon," I yell.

The sand starts pouring out, but suddenly the room walls begin to be pushed in by some outside force. The more the sand pours out, the smaller the room gets, but I stay on top of the sand.

"I'm not getting any lower. I hope the walls don't crush me."

"Don't worry. The casket will keep the walls apart." my aid cries.

a. Identify the parts of her story that match your ideas about a balloon opening.

a. Use the *Gas Properties* simulation to model a balloon being opened. Record how you used the sim, your observations. Be exact about what you held constant and what you varied.

b. Make note of how your ideas about what happens have changed.

c. Identify the parts of her story that don't really match what is happening in a balloon.

Trish, a chemistry student, wrote this to explain how she used the sim to model a balloon opening and the physics behind the process:

a. I modeled the initial conditions by putting in a pump full of molecules with *None* selected for *Constant Parameters*. Physics Explanation: *"The gas molecules are moving around with high translational motion colliding with the container. The temperature of the gas is directly related to the average velocity of the molecules. Furthermore the average kinetic energy of the air molecules inside and outside is the same because the temperature of both is the same. Since the container is elastic, the average force/area (pressure) from the molecules colliding with the container from the air in the container equals that from the air molecules outside the container"*

b. Next, leave *None* selected and open the container, hit *Pause* after about a second. Physics Explanation: *"Some molecules escape when the container is opened which does work (Fd) on the environment so the internal energy of the air in the balloon decreases as stated in the second law. The internal energy of an ideal gas is in the form of kinetic energy, so the KE decreases. The KE is directly related to the temperature of the gas, so the temp decreases. The pressure inside decreases because there are fewer molecules, going slower, colliding with the container."*

c. Last, make the *Pressure* a constant because balloons are elastic and press play. Physics Explanation: *"Since the rate of collisions on the inside is less than the rate on the outside, the environment does work (PV) on the balloon (elastic container). The volume decreases until the internal and external pressures are equal. The elasticity of the balloon is such that it doesn't totally collapse."*

d. The final conditions are not demonstrated by the sim, but the temperature would eventually equalize as stated in the second law. *"This happens through molecular collisions where momentum is transferred until the average speed of the molecules equals those of the environment."*

For 3-6, Read the scenario and use the simulation to help you understand what is happening. Record how you used the sim and your observations. Be exact about what you held constant and what you varied, and then write your physics explanations.

3. You add air to your car tire. *It is reasonable to assume that once tires have air, they are flexible but not stretchy, so they do not change volume if more gas is added.*

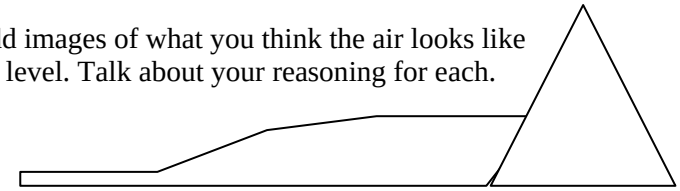
4. You jump down on your Nike air shoes (an elastic, closed air pocket is in the heel)

5. On a hot day, you find that it is harder than normal to open your gas tank.

6. You buy a bouquet of helium balloons for a friend's birthday in Denver, but some pop on the drive up to Evergreen.

7. It is well known that the higher you climb in the mountains that there is less oxygen.
   a. Talk with your partner about what you see in your mind when someone says, "The air is thinner in the mountains"?

   b. Draw a picture like this one, and then add images of what you think the air looks like at Sea level, Denver level and Mountain level. Talk about your reasoning for each.



Sea level Denver Mountains

   c. Use the simulation to see if your drawing makes sense. Make corrections to your diagram if necessary. Explain how using the simulation either supported the idea you had or how it helped you change your ideas.

8. Use the simulation to solve this question:

You check the pressure of a car tire on a very cold morning; when you filled it, the temperature was normal room temperature. Now, it is 20 psi, the tire says it should have 30 psi. Could it be just a change in temperature, or is it more likely that it has a leak? Explain how you used the simulation to determine your answer.

Tire pressure is always measured by your tire gauge as how much the pressure in the tire exceeds the atmospheric pressure. Let's assume the atmospheric pressure is 1 atm (14.7psi), so the current total pressure in the tire is 20 psi + 15 psi = 35 psi.(2.4 atm)