PhET Tips for Teacher Balloons and Buoyancy

Tips for controls:

- This sim is based on Gas Properties, but has more advanced features to enable students to see three physical situations: Hot Air Balloon (rigid open container with its own heat source), Rigid Sphere (rigid closed container), Helium Balloon (elastic closed container).
- It is important that particles are added to the closed containers, or you will see unnatural behavior.
- You can **Pause** the sim and then use **Step** to incrementally analyze.
- Be sure to open the **Tools** for quantitative analysis. Most are self-explanatory.
    - The **Layer tool** is draggable and allows you to see the pressure at a selected height. This is especially useful if you are using gravity.
    - Notice that the **Ruler** is in nanometers
- Under **Advanced Options,** you can uncheck **Molecules Collide**. This feature along with the **Energy Histograms** allows you to demonstrate how a Maxwell-Boltzmann distribution of molecular speeds forms once you allow collisions.

Important modeling notes / simplifications:

- The rigid sphere and helium balloon have small mass; the hot air balloon has more.
- The elasticity of the balloon is optimized based on our interviews to be small, but appropriate. The sim is not designed for calculating elasticity constant.
- This simulation includes the effects of work: if you let molecules out the T and P will decrease if V is constant; T and P will decrease if P is constant. Likewise, when you change the volume you see the effects of PV work.
- In the simulation, the incoming molecules are set to be pumped in at a temperature matching the current temperature of the gas (by setting their speed accordingly). So when you pump in new particles, the temperature won't change.
- If you want to set the temperature of incoming molecules, for example to see how adding 50K molecules to a gas at 300K affects the overall Temp, use the box under **Advanced Options.**
- To demonstrate the relationship between n and P (how does P change when I increase n and keep everything else constant), set the volume constant and add molecules.
- To demonstrate the relationship between P vs T, use the heater and keep volume constant and n constant (by not adding molecules).
- The heavy species are model representations of N_2 and the light are He. The size of the heavy particle is to scale, but the small one is not. The speeds are realistic. If you start with about 200 molecules and *None* for *Constant parameters*, you will get 1 atm at room temperature.

Insights into student use / thinking:

- Students may have more success if you have them start with the
- See the Teaching Tips for *Gas Properties* for more ideas.

Suggestions for sim use:

- For tips on using PhET sims with your students see: **Guidelines for Inquiry Contributions** and **Using PhET Sims**
- The simulations have been used successfully with homework, lectures, in-class activities, or lab activities. Use them for introduction to concepts, learning new concepts, reinforcement of concepts, as visual aids for interactive demonstrations, or with in-class clicker questions. To read more, see **Teaching Physics using PhET Simulations**
- For activities and lesson plans written by the PhET team and other teachers, see: **Teacher Ideas & Activities**