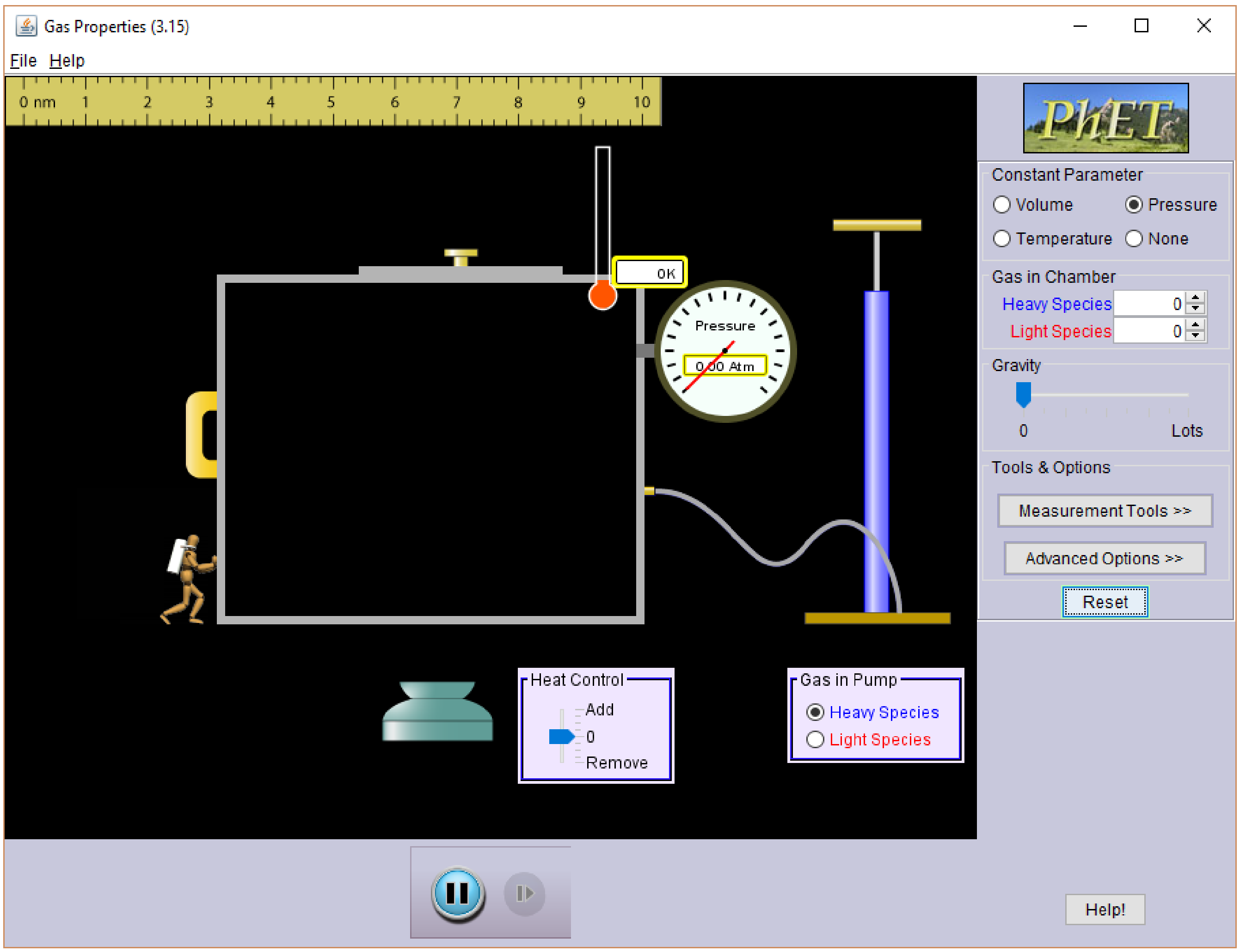
The Kinetic Theory of Gases

Lab Procedure – Answer the questions in red.

Download and run the Java application “gas-properties_en.jar”. This is the same app you used in the previous lab.

Kinetic molecular theory explains the large-scale characteristics of gases in terms of the behavior of the atoms and molecules that make up the gas. The “Gas Properties” simulation lets you see the individual particles in motion. It gives you control of a chamber of gas and lets you see the effects of the changes you make.



1. In the on-screen control panel, click the “Measurement Tools” button.

Remember that any time you need to; you can use the on-screen “Reset” button to return to the initial setup.

Quick review:

a) Use the pump. How do you manipulate the pump handle to get the ***greatest*** number of particles into the chamber in ***one*** stroke?

b) Describe how can you ***precisely*** control the number of particles injected into the chamber? (does not involve direct use of the pump.)

c) How can you release particles from the chamber (***without*** breaking the chamber)?

d) How can you add heat to the gas? How does the simulation illustrate this?

e) How can you remove heat from the gas? How does the simulation illustrate this?

f) How can you compress the gas (decrease its volume)?

g) How can you expand the gas (increase its volume)?

2. Create a chamber in which there is a mix of 50 moles light and 50 moles heavy gas particles. In the on-screen control panel, activate “Species Information.”

a) Which species—if either—has the greater average speed?

b) Does the temperature in the chamber reflect the average speed, momentum, potential energy, or kinetic energy of the particles?

Reset the chamber to have about 100 heavy particles. The temperature should be 300 K. Click the on-screen button to activate the “Center of mass markers.”

c) Consider the statement, “The average ***speed*** of air molecules in a room may be over 1000 mph (400 m/s), while their average ***velocity*** is approximately zero.” The particles in the simulation’s chamber are modeling the air molecules in a room. Cite evidence from the simulation to confirm or reject the quoted statement.

d) What is the name of the condition when the average velocity of atmospheric molecules around you is not zero? (*Hint:* It’s a common four-letter word starting with the letter “W.”)

3. a) Under what specific condition will the lid be blown off the chamber? Is it possible to blow the lid with just one particle in the chamber?

b) Is it possible to achieve a six-figure temperature? If so, how? If not, what's the highest temperature you could achieve?

Low-temperature physicists have not yet been able to cool anything to a temperature of absolute zero (0 degrees Kelvin).

Cool a simulated 50/50 sample (50 light and 50 heavy particles) gas sample to absolute zero.

c) When the temperature hits absolute zero, are the particles shown to be at rest?

c) Any ideas regarding what you observe?

4. Use the volume adjustment and the heat control to compress and cool a 50/50 sample to the smallest volume possible and to absolute zero. Now use the volume handle to rapidly expand the volume of the chamber all the way out.

a) Describe what happens.

b) Which species wins the race to the far side of the chamber? Why?