

PHET GAS PROPERTIES


Preparation:

1. Log on to a computer using your student username and password.
2. Go to <http://phet.colorado.edu/en/simulation/gas-properties> .
3. Select “Run Now”
4. Take 5 minutes to familiarize yourself with the controls.
 - a. Use the bicycle pump to add moles of gas.
 - b. Monitor the temperature as you manipulate the different controls.
 - c. Set a specific number of moles by using the arrows or typing in a specific value next to the word “Heavy Species”. For simplicity, we will let each little ball (and the number of balls) represent one mole of the gas.
 - d. Move the top to allow some of the gas to escape.
 - e. Add and remove heat.
 - f. Employ the humanoid to increase and decrease the volume
5. The following equations may prove helpful.

$$PV = nRT \quad \frac{P_1V_1}{nRT_1} = \frac{P_2V_2}{nRT_2} \quad U = \frac{3}{2}nRT = \frac{3}{2}PV \quad \Delta U = Q - W \quad \delta W = P\delta V$$

$$R = 0.082 \frac{\text{atm} \cdot \text{liter}}{\text{mol} \cdot \text{K}}$$

Procedure:

1. Experiment 1
 - a. Select the  button. Under “Constant Parameters”, select “None”.
 - b. Place 100 moles of gas into the cylinder and record the values in the table below. Since the pressure is constantly varying, observe it for several seconds and take the average between the highest and the lowest values observed.
 - i. Compute the volume.
 - ii. Compute the internal energy. (Hint: Remember that it is always better to use measured values rather than computed values for subsequent computations.)

P (atm)	V (L)	n (mol)	T (K)	U (J)	Q (J)	W (J)


- c. Use the humanoid to compress the gas until the temperature stabilizes as close as you can get to 600K (record the actual temperature in the table).
- Compute the new volume.
 - Compute the new internal energy.
 - Determine how much work the humanoid did.

P (atm)	V (L)	n (mol)	T (K)	U (J)	Q (J)	W (J)

- d. Under “Constant Parameters”, select “volume”. Remove heat until the temperature stabilizes as close as you can get to 100K.
- Compute the new internal energy.
 - Determine how much heat was removed.

P (atm)	V (L)	n (mol)	T (K)	U (J)	Q (J)	W (J)

2. Experiment 2

- a. Select the  button. Under “Constant Parameters”, select “Volume”.
- b. Place 75 moles of gas into the cylinder and record the values in the table below after allowing it to stabilize.
- Compute the volume.
 - Compute the internal energy.

P (atm)	V (L)	n (mol)	T (K)	U (J)	Q (J)	W (J)

- c. Open the top lid until the temperature goes down to 100K (as close as you can get, you can always start over) and record the values in the table below after allowing it to stabilize.
- Compute the number of moles remaining. (Remember that volume is still constant).
 - Compute the internal energy.

P (atm)	V (L)	n (mol)	T (K)	U (J)	Q (J)	W (J)

- What was the loss in internal energy? _____
- Was the loss in internal energy due to heat or work? Explain why. _____

- d. Under “Constant Parameters”, select “None”. Use the humanoid to compress the gas until the temperature gets back to 300K and record the values in the table below after allowing it to stabilize.
- How much work do you think the humanoid did on the gas? _____

- ii. Compute the new volume. (Remember that moles did not change.)
- iii. Compute the internal energy.

P (atm)	V (L)	n (mol)	T (K)	U (J)	Q (J)	W (J)

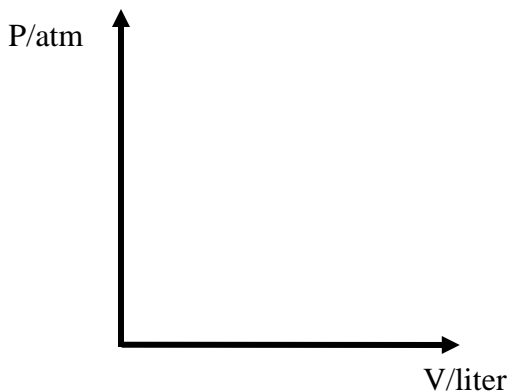
- iv. What was the increase in internal energy? _____
 - v. How does that compare to your guess in i. above? If you guessed wrong, what do you think that you failed to consider in your guess? _____
- _____
- _____

3. Experiment 3

- a. Select the button. Under “Constant Parameters”, select “Temperature”.
- b. Place 50 moles of gas into the cylinder and record the values in the table below after allowing it to stabilize.
 - i. Compute the volume.
 - ii. Compute the internal energy.

P (atm)	V (L)	n (mol)	T (K)	U (J)	Q (J)	W (J)

- c. Use the humanoid to decrease the volume as much as he can. Record the values in the table below after allowing it to stabilize. As you do, watch the heat putter-inner/taker-outer.
 - i. What happened with the heat putter-inner/taker-outer? _____
 - ii. Compute the volume.
 - iii. Compute the internal energy.
 - iv. On the P-V diagram below, graph and label the process just performed (no scales, just the four points)



- v. Compute the amount of work done *on* the gas by finding the area under the curve

vi. Compute the amount of heat energy released by the gas

P (atm)	V (L)	n (mol)	T (K)	U (J)	Q (J)	W (J)

d. Under “Constant Parameters”, select “Pressure”. Add heat until the temperature increases to 600K and allow the gas to stabilize as much as possible.

i. Once stabilized, does the volume stay constant? Why or why not? _____

ii. Compute the average volume.

iii. Compute the internal energy.

iv. Compute the amount of work done *by* the gas (remember that pressure stayed constant so no need to graph it)

v. Compute the amount of heat energy released by the gas

P (atm)	V (L)	n (mol)	T (K)	U (J)	Q (J)	W (J)

The answers on this lab are a product of my own work and effort. Though I may have received some help in understanding the concepts and/or requirements, I did the work myself.

Student Signature

(for electronic submission, type student number in lieu of signature)

ROOM FOR IMPROVEMENT

APPLICABILITY:

In terms of the material covered thus far, this lab was given:

too late in the course at the right time in the course too late in the course

In terms of degree of difficulty, this lab was:

too easy just about right too hard

In terms of helping you understand the material, this lab was:

not helpful somewhat helpful very helpful

COMMENTS:

IMPROVEMENT: This lab can be improved by: