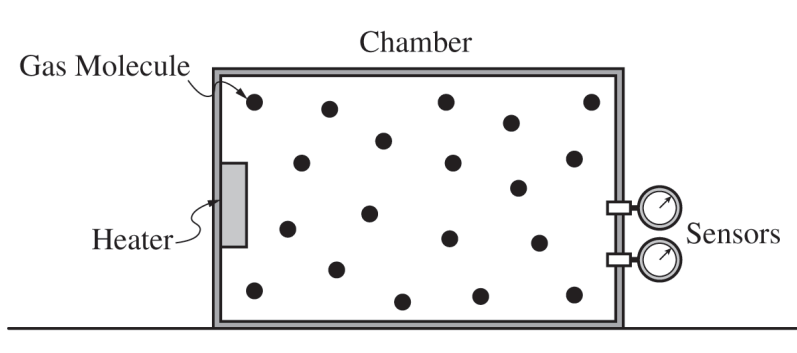




Note: Figure not drawn to scale.

Figure 1

2. (12 points, suggested time 25 minutes)

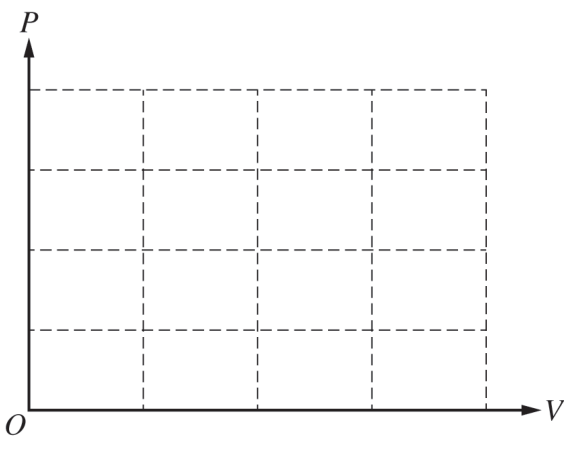
In Experiment 1, shown in Figure 1, a sample of an ideal gas is contained in an insulated, sealed chamber with thin, rigid walls. The chamber contains a heater and sensors that measure the temperature and pressure of the gas. A student is asked to design an experiment to determine the number N of molecules of the gas contained in the chamber.

- (a) **Describe** a procedure for collecting data that would allow the student to determine an experimental value for N . Provide enough detail so that a student could replicate the experiment, including any steps necessary to reduce experimental uncertainty.

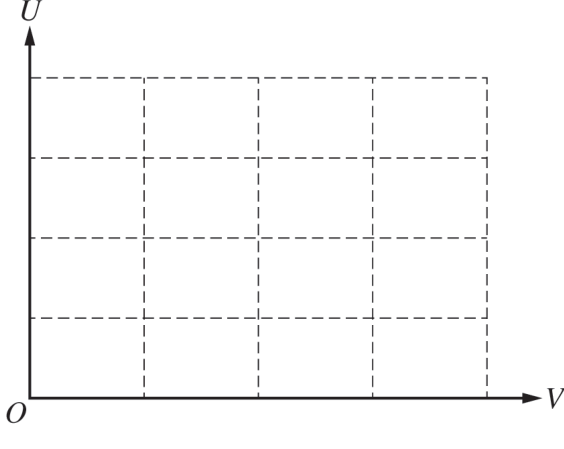
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Continue your response to **QUESTION 2** on this page.

- (b)
- i. On the following axes, **sketch** a curve or line to represent the expected relationship between the pressure P and the volume V of the gas while the heater is on. **Draw** an arrow on the curve or line to represent the direction of the resulting thermal process.



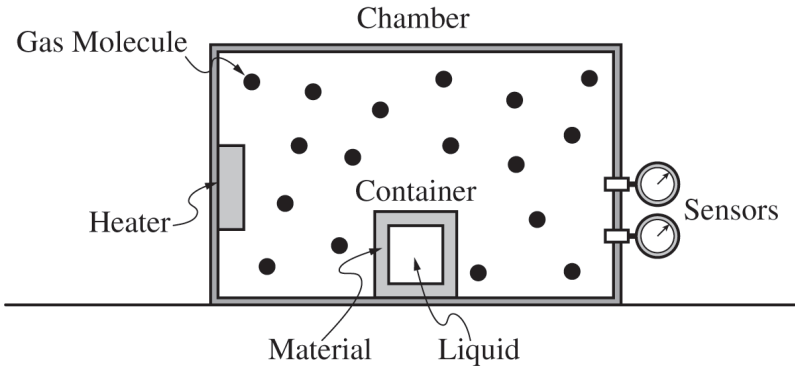
- ii. On the following axes, **sketch** a curve or line to represent the expected relationship between the internal energy U and the volume V of the gas while the heater is on. **Draw** an arrow on the curve or line to represent the direction of the resulting thermal process.



- iii. Briefly **justify** why the curve or line drawn in part (b)(ii) has the shape that you sketched.

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Continue your response to **QUESTION 2** on this page.



Note: Figure not drawn to scale.

Figure 2

In Experiment 2, shown in Figure 2, a liquid-filled container that is completely wrapped with a material of uniform thickness 0.01 m is inside the sealed chamber that is filled with an ideal gas. The material has a total area of 0.06 m^2 in contact with the gas. The heater is turned on. As the temperature T_G of the gas increases, the following data for the temperature T_L of the liquid and the rate $\frac{Q}{\Delta t}$ of energy transfer are collected.

	T_G (K)	T_L (K)	$\frac{Q}{\Delta t} \left(\frac{\text{J}}{\text{s}} \right)$	
	295	295	0.0	
	371	303	26.3	
	425	308	43.1	
	475	313	60.0	
	528	323	75.0	

- (c) The student is asked to determine an experimental value of the thermal conductivity k of the material used to wrap the container inside the sealed chamber.

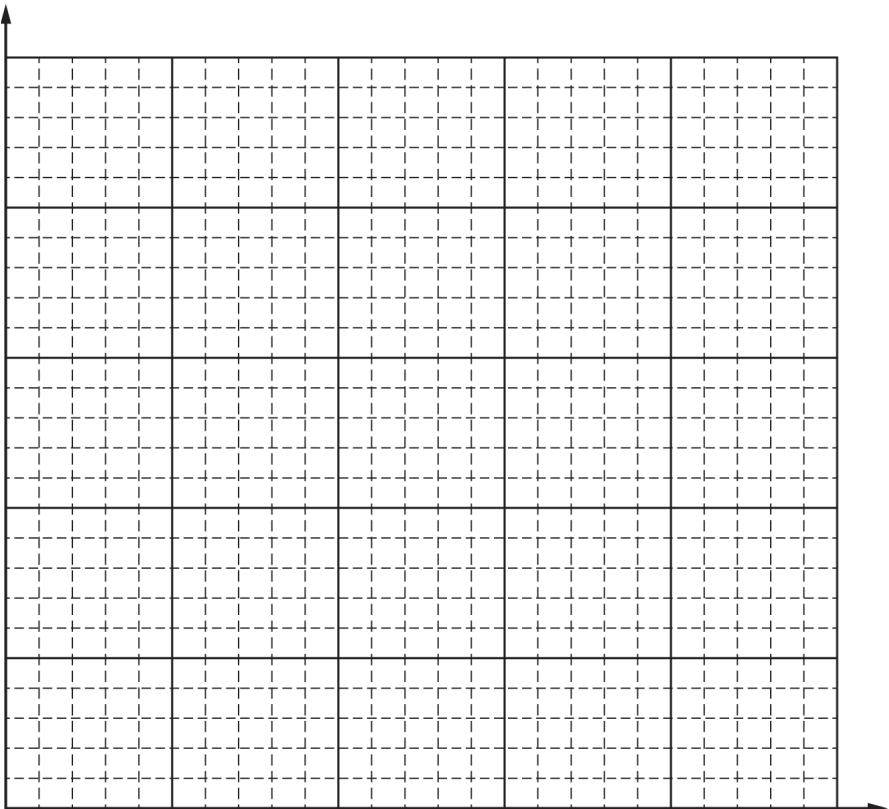
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Continue your response to **QUESTION 2** on this page.

- i. **Indicate** what measured and/or calculated quantities could be graphed to yield a straight line that could be used to calculate an experimental value for the thermal conductivity k of the material. Use the blank columns in the table to list any calculated quantities you graph in addition to the data provided.

Vertical Axis: _____ Horizontal Axis: _____

- ii. **Plot** the data points for the quantities indicated in part (c)(i) on the graph provided. Clearly scale and **label** all axes, including units, as appropriate.



- iii. **Draw** the best-fit line for the data graphed in part (c)(ii).

- (d) Using the best-fit line, **calculate** an experimental value for k .

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