AP2 Thermo Review FR

PHYSICS 2

Section II

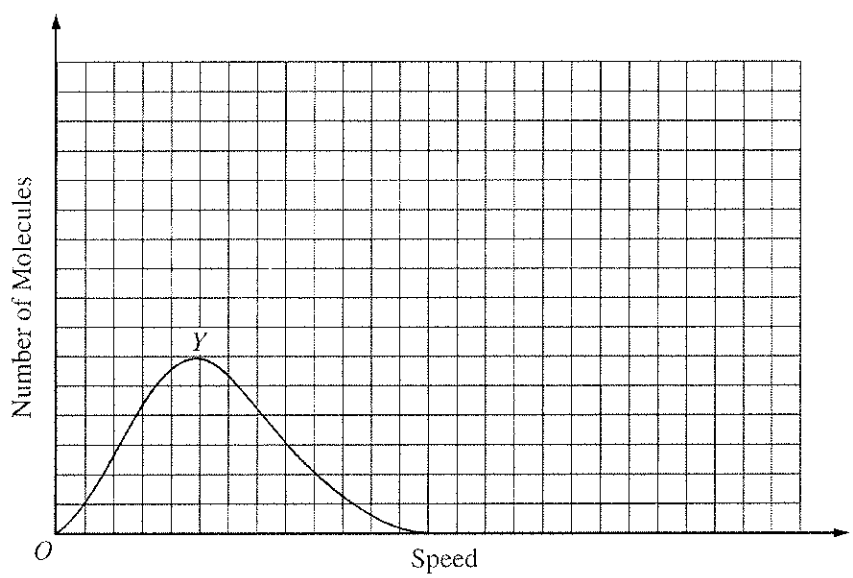
4 Questions

Time—90 minutes

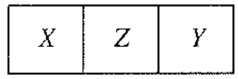
Directions: Questions 2 and 3 are long free-response questions that require about 25 minutes each to answer and are worth 12 points each. Questions 1 and 4 are short free-response questions that require about 20 minutes each to answer and are worth 10 points each. Show your work for each part in the space provided after that part.

1. (10 points, suggested time 20 minutes)
Three samples of a gas, *X*, *Y*, and *Z*, are prepared. Each sample contains the same number of molecules, but the samples are at different temperatures. The temperature of sample *X* is T_X, the temperature of sample *Y* is lower than that of sample *X*, and the temperature of sample *Z* is lower than that of sample *Y* $(T_X > T_Y > T_Z)$.

(a) The graph below shows the distribution of the speeds of the molecules in sample *Y*. On the graph, sketch and label possible distributions for sample *X* and sample *Z*.



The three samples with initial temperatures $T_X > T_Y > T_Z$ are placed in thermal contact, with sample Z in the middle, as shown below, and the samples are insulated from their surroundings. The samples can exchange thermal energy but not gas molecules. The samples eventually reach equilibrium, with a final temperature greater than T_Y.



(b) In a few sentences, describe the change over time in the average kinetic energy of the molecules of each sample, from initial contact until they reach equilibrium. Explain how these changes relate to the energy flow between the pairs of samples that are in contact.

Sample X

Sample Y

Sample Z

(c) Indicate whether the net entropy of sample X increases, decreases, or remains the same as a result of the process of reaching equilibrium.

____ Increases ____ Decreases ____ Remains the same

Justify your answer at the microscopic level.

(d) For the three-sample system, indicate whether the entropy of the system increases, decreases, or remains the same.

____ Increases ____ Decreases ____ Remains the same

Justify your answer.

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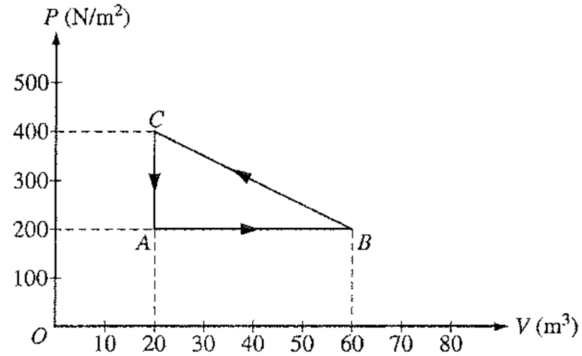


2003Bb5. One mole of an ideal gas is taken around the cycle $A \to B \to C \to A$ as shown on the PV diagram above.

a. Calculate the temperature of the gas at point *A*.

b. Calculate the net work done on the gas during one complete cycle.

c. i. Is heat added to or removed from the gas during one complete cycle?

_____added to the gas _____removed from the gas

ii. Calculate the heat added to or removed from the gas during one complete cycle.

d. After one complete cycle, is the internal energy of the gas greater, less, or the same as before?

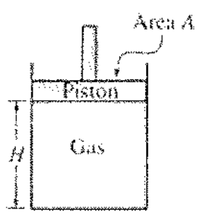
______greater ______less ______the same

Justify your answer.

e. After one complete cycle, is the entropy of the gas greater, less, or the same as before?

______greater ______less ______the same

Justify your answer.



2005B6. An experiment is performed to determine the number *n* of moles of an ideal gas in the cylinder shown above. The cylinder is fitted with a movable, frictionless piston of area *A*. The piston is in equilibrium and is supported by the pressure of the gas. The gas is heated while its pressure P remains constant. Measurements are made of the temperature *T* of the gas and the height *H* of the bottom of the piston above the base of the cylinder and are recorded in the table below. Assume that the thermal expansion of the apparatus can be ignored.

T (K)	*H* (m)
300	1.11
325	1.19
355	1.29
375	1.37
405	1.47

a. Write a relationship between the quantities *T* and *H*, in terms of the given quantities and fundamental constants, that will allow you to determine *n*.

b. Plot the data on the axes below so that you will be able to determine *n* from the relationship in part (a). Label the axes with appropriate numbers to show the scale.

c. Using your graph and the values A = 0.027 m² and P = 1.0 atmosphere, determine the experimental value of *n*.