

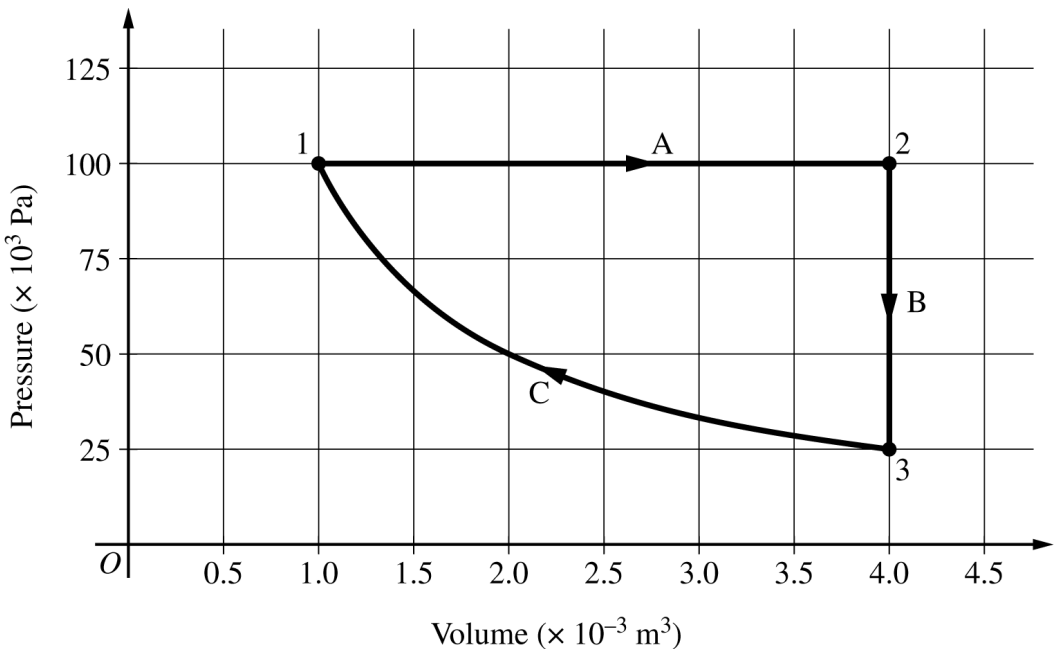
PHYSICS 2

SECTION II

Time—1 hour and 30 minutes

4 Questions

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



1. (10 points, suggested time 20 minutes)

A sample of ideal gas is taken through the thermodynamic cycle shown above. Process C is isothermal.

(a) Consider the portion of the cycle that takes the gas from state 1 to state 3 by processes A and B. Calculate the magnitude of the following and indicate the sign of any nonzero quantities.

- The net change in internal energy  $\Delta U$  of the gas
- The net work  $W$  done on the gas
- The net energy  $Q$  transferred to the gas by heating

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(b) Consider isothermal process C.

- Compare the magnitude and sign of the work  $W$  done on the gas in process C to the magnitude and sign of the work in the portion of the cycle in part (a). Support your answer using features of the graph.
- Explain how the microscopic behavior of the gas particles and changes in the size of the container affect interactions on the microscopic level and produce the observed pressure difference between the beginning and end of process C.

|                     |                     |
|---------------------|---------------------|
| Sample 2<br>State 2 | Sample 3<br>State 3 |
|---------------------|---------------------|

(c) Consider two samples of the gas, each with the same number of gas particles. Sample 2 is in state 2 shown in the graph, and sample 3 is in state 3 shown in the graph. The samples are put into thermal contact, as shown above. Indicate the direction, if any, of energy transfer between the samples. Support your answer using macroscopic thermodynamic principles.

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Use a pencil or pen with black or dark blue ink only. Do NOT write your name. Do NOT write outside the box.