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5. (10 points)

One mole of an ideal gas is initially at pressure $P_1$, volume $V_1$, and temperature $T_1$, represented by point $A$ on the $PV$ diagram above. The gas is taken around cycle $ABCA$ shown. Process $AB$ is isobaric, process $BC$ is isochoric, and process $CA$ is isothermal.

(a) Calculate the temperature $T_2$ at the end of process $AB$ in terms of temperature $T_1$.

\[ \frac{\bar{R} U_1}{T_1} = \frac{\bar{R} x_v}{T_2} \]

(b) Calculate the pressure $P_2$ at the end of process $BC$ in terms of pressure $P_1$.

\[ \frac{P_1 x_v}{T_2} = \frac{P_2}{T_1} \]

\[ P_2 = 2P_1 \]

For $T_2 = \frac{T_1}{2}$.

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GO ON TO THE NEXT PAGE.
(c) Calculate the net work done on the gas when it is taken from \( A \) to \( B \) to \( C \). Express your answer in terms of \( P_i \) and \( V_i \).

The work done on the gas is the area under the shaded region which was the work done on gas by surrounding.

\[ W = \int (V_i - \frac{1}{2} V) \times P_i \]

\[ = \frac{V_i P_i}{2} \]

(d) Indicate below all of the processes that result in heat being added to the gas.

\[ \text{AB} \quad \sqrt{BC} \quad \sqrt{CA} \]

Justify your answer.

1) \( \text{Process } A \rightarrow B \)

\[ \Delta U = \frac{3}{2} \times 8.31 \times (T_e - T_i) \]

\[ = \frac{3}{2} \times 8.31 \times \left(-\frac{723}{132} \right) \]

\[ = -6.23 T_i \]

\[ Q = -P_i \times \left( \frac{V_i}{2} - V_i \right) \]

\[ = -P_i \left( -\frac{V_i}{2} \right) \]

\[ = \frac{P_i V_i}{2} \]

\[ Q = -6.23 T_i - \frac{P_i V_i}{132} < 0 \]

\[ Q = \Delta U > 0 \]

\[ \Theta = -Q > 0 \]

\[ \Theta = -w > 0 \]

GO ON TO THE NEXT PAGE.
5. (10 points)

One mole of an ideal gas is initially at pressure $P_1$, volume $V_1$, and temperature $T_1$, represented by point $A$ on the $PV$ diagram above. The gas is taken around cycle $ABCA$ shown. Process $AB$ is isobaric, process $BC$ is isochoric, and process $CA$ is isothermal.

(a) Calculate the temperature $T_2$ at the end of process $AB$ in terms of temperature $T_1$.

\[
\frac{RV_1}{T_1} = \frac{RQV_2}{T_2} \quad \Rightarrow \quad V_2 = \frac{V_1}{2} \\
\frac{V_1}{T_1} = \frac{V_2}{T_2} = T_1 = 2T_2 \\
T_2 = \frac{T_1}{2}
\]

(b) Calculate the pressure $P_2$ at the end of process $BC$ in terms of pressure $P_1$.

\[
\frac{P_2}{T_2} = \frac{P_1}{T_1} \\
P_2 = \frac{P_1}{T_1} \times T_2 = \frac{P_1}{2T_2} = \frac{P_1}{2}
\]
(c) Calculate the net work done on the gas when it is taken from A to B to C. Express your answer in terms of $P_1$ and $V_1$.

\[ W = -P \Delta V \]
\[ = -\frac{P_1}{2} \left( \frac{V_1}{2} - V_1 \right) \]

(d) Indicate below all of the processes that result in heat being added to the gas.

\[ \text{AB} \quad \sqrt{BC} \quad \sqrt{CA} \]

Justify your answer.

\[ \text{AB: } \Delta U = Q + W \quad PV = nRT \]
\[ W \text{ is positive} \quad \downarrow \quad \downarrow \]
\[ \text{and therefore temperature should increase} \]
\[ \text{but it decreases.} \]
\[ Q \text{ is negative.} \]

\[ \text{BC: } \Delta U = Q + W \quad \uparrow \quad \uparrow \]
\[ W = 0 \]
\[ P \text{ increases & temperature increases.} \]
\[ Q \text{ is added.} \]

\[ \text{CA: } \text{isothermal.} \quad PV = nRT \]
\[ \text{Work is negative and so } Q \text{ has to be positive} \]
\[ \text{in order to keep the constant temperature.} \]

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