Carnot Cycle Exercise

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$T_H = 490$ K
$V_c = 1.90 \times 10^{-3}$ m^3

1. Purpose

The goal of the exercise is to perform various calculations related to the Carnot cycle.

2. Derivations

2.1. Temperature–Volume Relationship for Adiabatic Process

Given:

$$PV = nRT$$
$$P_i V_i^\gamma = P_f V_f^\gamma$$

$$\begin{aligned} P_i V_i^\gamma &= P_f V_f^\gamma \\ P_i V_i V_i^{\gamma-1} &= P_f V_f V_f^{\gamma-1} \\ nRT_i V_i^{\gamma-1} &= nRT_f V_f^{\gamma-1} \\ T_i V_i^{\gamma-1} &= T_f V_f^{\gamma-1} \end{aligned}$$

3. Results

3.1. Moles of Gas (n)

$$\begin{aligned} P_c V_c &= nRT_c \\ P_c V_c &= nRT_C \\ n &= \frac{P_c V_c}{RT_C} \\ n &= 0.0770 \text{ mol} \end{aligned}$$

3.2. Pressure (P_b) and Volume (V_b) at b

$$\begin{aligned} T_b V_b^{\gamma-1} &= T_c V_c^{\gamma-1} \\ V_b &= V_c \left(\frac{T_c}{T_b}\right)^{\frac{1}{\gamma-1}} \\ V_b &= V_c \left(\frac{T_C}{T_H}\right)^{\frac{1}{\gamma-1}} \\ V_b &= 5.57 \times 10^{-4} \text{ m}^3 \end{aligned}$$

$$\begin{aligned} P_b V_b &= nRT_b \\ P_b V_b &= nRT_H \\ P_b &= \frac{nRT_H}{V_b} \\ P_b &= 5.63 \times 10^5 \text{ Pa} \end{aligned}$$

Table 1. Pressure, Volume, and Temperature for Key Points

Point	P (Pa)	V (m^3)	T (K)
a			490
b	5.63×10^5	5.57×10^{-4}	490
c	1.01×10^5	1.90×10^{-3}	300
d			300

4. Conclusion

[1] Karen Schnurbusch, *Physics 4B Lab Book*, Mt. San Antonio College, 2023, pp. 35-38.
[2] Karen Schnurbusch, *Physics 4B Equations*, Mt. San Antonio College, 2023, pp. 1-3.