3.6 PROBLEMS

Problem 3.6.1. Two moles of a monatomic ideal gas performs a Carnot cycle between 300 K and 500 K. The starting volume of the gas before isothermal expansion was 3×10^{-3} m^3, and it expands to double the volume in the isothermal step. Find the total amount of work done and heat absorbed from the high temperature reservoir in each cycle.

Problem 3.6.2. The work output of a Carnot engine operating between temperatures T_1 and T_2 with $T_1 > T_2$ is used to drive a refrigerator between temperatures T_3 and T_4 where $T_3 > T_4$. Find the ratio of heat taken from thermal baths T_1 and T_4 in terms of the four temperatures.

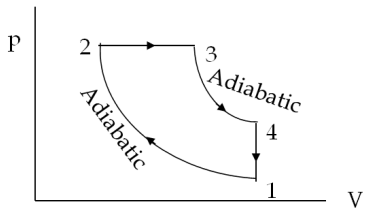

Figure 3.9: The Diesel Cycle.

Problem 3.6.3. Consider an ideal gas operating in the air-standard **Diesel cycle** shown in Fig. 3.9. Find a formula for the efficiency of the engine in terms of V_1, V_2, V_3, V_4 and γ.

Problem 3.6.4. Consider an ideal gas Joule cycle, also called the **Brayton cycle**, shown in the Fig. 3.10. Find a formula for the efficiency of the engine using this cycle in terms of P_1, P_2 and γ.

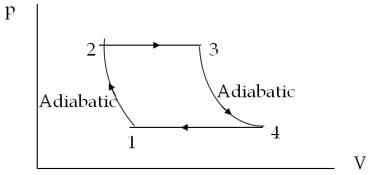

Figure 3.10: The Brayton Cycle.

Problem 3.6.5. A refrigerator has 3 cu.ft. of space to be maintained at $0°C$. Heat leaks in the refrigerated space at a rate of 0.1 calories per minute. If the outside temperature is $35°C$, what will be the minimum amount of power needed to maintain the temperature inside the refrigerator?

Problem 3.6.6. Find a formula for the coefficient of performance of refrigerator using an ideal gas as the working substance operating in the cycle shown in Fig. 3.11 in terms of the properties of the three states labeled 1, 2, 3.

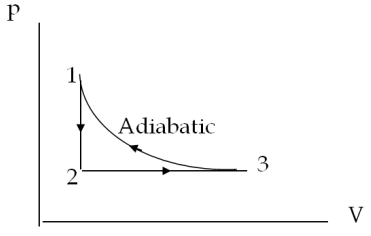

Figure 3.11: Problem 3.6.6.

Problem 3.6.7. A Carnot refrigerator, working between $0°C$ and $30°C$ is used to cool a bucket of water containing 10 L of water at $30°C$ to $5°C$ in two hours. Find the total amount of work needed.