This session will be like an “in-class homework” assignment because we will not have an opportunity to turn in homework on the 2nd law of thermodynamics before Test 3. Therefore, problems (1-3) will be collected and graded (although the points received will be in the manner of past in-class assignments, and no more than the usual for an in-class assignment).

A. Do not submit this problem

Consider the heat engines in the figure above.
(a) Which, if any, of these violates the 1st law of thermodynamics? Explain clearly.
(b) Which, if any, of these violates the 2nd law of thermodynamics? Explain clearly.

1. A heat engine using 1.0 mol of a monatomic gas follows the cycle shown in the figure on the right. During the process 1 to 2, 3750 J of heat energy is transferred to the gas.
(a) Determine \( W, Q, \) and \( \Delta E_{\text{int}} \) for each of the four processes in the cycle. Display your results in a table.
(b) What is the thermal efficiency of this heat engine?

2. A heat engine uses a diatomic gas that follows the cycle shown in the figure on the right.
(a) Determine \( P, V, \) and \( T \) at point 2.
(b) Determine \( W, Q, \) and \( \Delta E_{\text{int}} \) for each of the three processes in the cycle. Display your results in a table.
(c) How much work does this engine do per cycle, and what is its thermal efficiency?

3. The figure on the right shows a Brayton cycle, in which adiabatic expansion (3 to 4) and adiabatic compression (1 to 2) are followed by isobaric (constant pressure) processes (4 to 1, and 2 to 3) respectively. Assume that the gas is diatomic. The heat input is 2.0 MJ (i.e., \( 2.0 \times 10^6 \) J) per cycle. Explicitly find the work done in each cycle, and use your results to determine the thermal efficiency of the engine.