MAE 110A - Homework Assignment Requirements

Homework assignments have the following requirements. Any homework not following these requirements will be returned ungraded.

1. All homework must be done neatly on 8.5 × 11 paper (single-sided on clean, new paper, stapled together, no frayed edges) with each problem and final solution clearly indicated. Illegible homework will be returned ungraded.

   The following information must appear on the first/cover page:
   - Name and Date
   - Course number
   - Homework number

   Illegible homework will be returned ungraded.

2. The following is the standard format for organizing and presenting the solution to each homework problem† (See sample solution on next page):
   (a) **Problem Description** - include the following (* very important):
      - Basic description and given information
      - *Sketch of problem/geometry and system considered (use dashlines for system)
      - Initial state (knowns and unknowns)
      - Final state (knowns and unknowns)
      - *Appropriate property diagrams (indicate state points, process lines)
      - What is to be determined
   (b) **Engineering Model** - list all required simplifying assumptions and idealizations.
   (c) **Basic Equations** - general form of relevant fundamental laws, equations, definitions.
   (d) **Analysis**
      - clear description of procedure to reduce basic equations to give solution.
      - keep equations in variable form (no numbers) for as long as possible.
      - identify all tables and charts needed for additional data, property values (e.g., "..from Table B.1.1").
      - substitute numerical values into final equations. be sure to specify all units and unit conversions.
      - clearly indicate final answer(s) with underline or box.
      - check solution - correct sign, reasonable numerical values?)
   (e) **Discussion of Solution** - as needed (what you learned, key aspects of solution, etc).

   † Note: Some of the problems (e.g., Ch 1 problems) may not require all the above items. Follow the standard format as best as you can or as appropriate.

3. Grades will be determined by student’s:
   - Understanding of the problem.
   - Identification of necessary procedure to obtain solution.
   - Clear and precise description of solution.
   - Correct numerical answers.
Problem Description:

A frictionless piston is raised slowly by heating the gas contained in the cylinder.

Given:

\[ \begin{align*}
    P_1 &= 0.2 \text{ MPa} \\
    V_1 &= 1.0 \text{ m}^3 \\
    V_2 &= 2.0 \text{ m}^3 \\
    Q_{12} &= 20000 \text{ kJ} = 20 \text{ MJ}
\end{align*} \]

Determine: \( \Delta U_{12} \) - change in internal energy.

Engineering Model:
1. Quasi-equilibrium process
2. System is the gas only.
3. Negligible kinetic and potential energy effects.

Basic Equations:

1. Law for closed system: \( Q_{in} + W_{in} = Q_{out} + W_{out} + \Delta K + \Delta PE + \Delta U \) \hspace{1cm} (1)

2. Work: \( W_{12} = \int P \cdot dV \) \hspace{1cm} (2)

Steps:

Apply 1st law to system:

\[ Q_{in,12} = W_{out,12} + \Delta K + \Delta PE + \Delta U_{12} \] \hspace{1cm} (3)

Solving for \( \Delta U_{12} \):

\[ \Delta U_{12} = Q_{in,12} - W_{out,12} \] \hspace{1cm} (4)

To determine \( W_{out,12} \), use Eq. (2):

\[ W_{out,12} = \int P \cdot dV = P \cdot (V_2 - V_1) \] \hspace{1cm} (5)

Substituting (4) into (3):

\[ \Delta U_{12} = U_2 - U_1 = Q_{in,12} - P \cdot (V_2 - V_1) \] \hspace{1cm} (6)

Numerical Substitution:

\[ Q_{in}(4) \rightarrow W_{out,12} = 0.2 \text{ MPa} \cdot (2.1 - 1.0) \text{ m}^3 \cdot \frac{11.5 \text{ MJ}}{1 \text{ kPa}} \cdot \frac{1 \text{ MPa}}{1 \text{ kPa}} = 0.2 \text{ MJ} \]

\[ Q_{in}(5) \rightarrow \Delta U_{12} = 2 - 0.2 = 1.8 \text{ MJ} \]