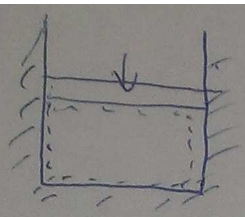
Quiz 4 Commentary: Using a Control Mass Approach

I really didn't dream that students would have used a control mass approach for this problem. Here are some reasons that you should have been thinking of a control volume approach first:

- We'd had 5 lectures, a QA and a tutorial on control volume analysis, as well as online problems, but no quiz yet.
- Rogers Arena, mentioned in the problem statement, was full of flow systems.
- The Quiz 4 study package specifically mentioned that you would have a SSSF problem on the exam.
- Previous practice exams in this folder focussed on SSSF problems.

However, the wording of the problem does not actually say that the problem uses a SSSF compression, so it is possible that a reasonable person, knowing thermodynamics but having missed the last 2 weeks of class, would have assumed that the processes occurred in a piston-cylinder arrangement. If you did this correctly (solution on next page), I will remark your quiz. Before I would consider adding marks, you would need to show that you had a diagram that was consistent with the control-mass version of the first law, and you would need to use u_2-u_1 to get the work, as well as $u_2=h_2-p_2v_2$.



1 → 2 isentropic compression

$U_2 - U_1 = \cancel{Q_2}^{\,0} - {}_1W_2$

${}_1W_2 = U_1 - U_2$

$= (H_1 - P_1V_1) - (H_2 - P_2V_2)$

$\frac{W}{m} = w_{12} = \underbrace{(h_1 - h_2)}_{\text{this part from T-s diagram}} - (P_1v_1 - P_2v_2)$

$P_1 = 100\ kPa \quad v_1 \sim 1000\ cc/g$

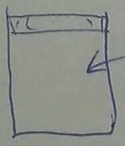
$= 1000 \times 10^{-3} = 1\ m^3/kg$

$P_2 \sim 2500\ kPa \quad v_2 = 150\ cc/g \sim 0.15\ m^3/kg$

$w_{12} = (2680 - 3450) - \left(100\ kPa\left(1\ \frac{m^3}{kg}\right)\right) + 2500(.15)$

$= -770\ \frac{kJ}{kg} - 100\ \frac{kJ}{kg} + 375\ \frac{kJ}{kg} = -495\ \frac{kJ}{kg}$

For 2 → 3



$P = \text{constant} = P_2 = P_3$

$U_3 - U_2 = q_{23} - w_{23} = q_{23} - (P_3v_3 - P_2v_2)$

$h_3 - h_2 = q_{23}$ so the answer is the same as for the SSSF problem

$q_{23} \sim 980 - 3450 = -2470\ \frac{kJ}{kg}$

(allowance for errors reading T-s better than 10%).