SET Problem
Session 6

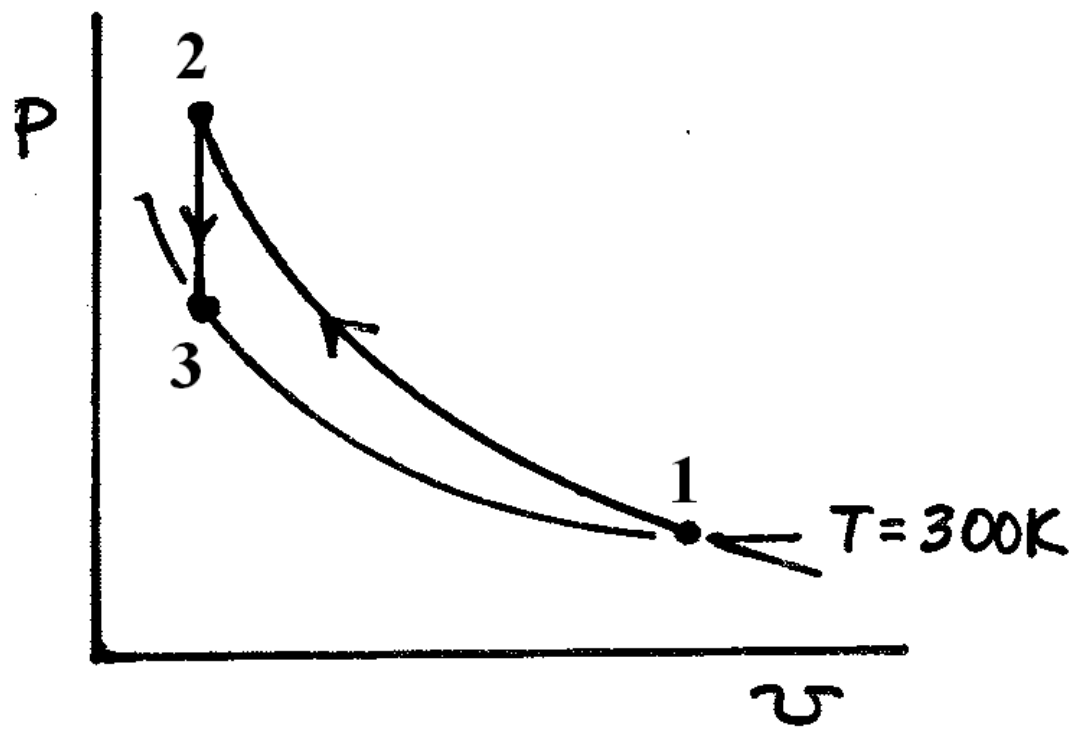
Problem Statement

- Air is compressed adiabatically from $p_1 = 1\text{bar}$, $T_1 = 300\text{K}$ to $p_2 = 15\text{bar}$, $v_2 = 0.1227\text{m}^3/\text{kg}$. The air is then cooled at constant volume to $T_3 = 300\text{K}$. Assuming ideal gas behavior, and ignoring kinetic and potential energy effects, calculate the work for the first process and the heat transfer for the second process, each in kJ per kg of air. Solve the problem each of the two ways:

  (a) Using data from the table of ideal gas properties of air.

  (b) using a constant specific heat evaluated at 300K.

Graph



Solution

Work done (first process)

Part a: Using Ideal Gas Equation

$PV=RT$

$T_2=P_2V_2/R$

$T_2=(15*0.1227)/8.314$

$T_2=641.3K$

Now Work Done(energy balance equation)

$\Delta K.E + \Delta P.E + m(u_2-u_1) = Q_{1-2} - W_{1-2}$

$W_{1-2}/m=u_1-u_2$

$W_{1-2}/m=214.07-466.5=-252.4kJ/Kg$

Heat Transfer(Second Process)

Using energy balance equation

$\Delta K.E + \Delta P.E + m(u_3 - u_2) = Q_{2-3} - W_{2-3}$

$Q_{2-3}/m = u_3 - u_2$

$T_3 = T_1, U_3 = U_1$

$Q_{2-3}/m = 214.07 - 466.5 = -252.4 kJ/Kg$

Part b:Using constant specific heat evaluated at 300K

$W_{1-2}/m=C_v(T_1-T_2)$

$W_{1-2}/m=0.718(300-641.3)$

$W_{1-2}/m=-245kJ/Kg$

$Q_{2-3}/m= W_{1-2}/m =-245kJ/Kg$