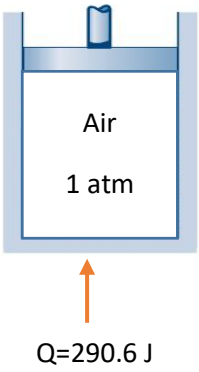
ÇANKAYA UNIVERSITY
DEPARTMENT OF MECHANICAL ENGINEERING
ME211 THERMODYNAMICS I
Quiz #2- Solution

Air at 1 atm and 20°C occupies an initial volume of 0.001 m^3 in a piston cylinder assembly. The air is confined by the piston which has a constant restraining force so that pressure always remains constant. Now 290.6 J heat is added to the system until the temperature reaches 260 °C. Calculate the work the gas does on the piston and the change in internal energy.



$U_2 - U_1 = Q_{12} - W_{12}$

$\bar{R} = 8.314\ kJ/kmolK$, M= 28.97 kg/kmol

$PV = mRT$

1 atm=101.325 kPa

$W = \int_{V_1}^{V_2} p\,dV$

$R = \frac{\bar{R}}{M}$

State 1

$T_1 = 20°C = 293K$
$P_1 = 1\ atm = 101,3\ kPa$
$V_1 = 0,001\ m^3$

$m = \frac{PV}{RT}$ where $R = \frac{\bar{R}}{M} = 0,287\ kJ/kgK$

State 2

$T_2 = 260°C = 533\ K$
$P_2 = P_1 = 101,3\ kPa$
$V_2 = ?$

$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

$\Rightarrow \frac{V_2}{V_1} = \frac{T_2}{T_1} \Rightarrow V_2 = \frac{533}{293} \cdot 0,001 \Rightarrow V_2 = 0,00182\ m^3$

- $_1W_2 = \int_{V_1}^{V_2} P\,dV = P(V_2 - V_1) = 101,3 \cdot (0,00182 - 0,001) = 0,0829\ kJ$
  $\Rightarrow W = 82,97 \simeq 83\ J$
- $_1Q_2 - {}_1W_2 = \Delta U \rightarrow \Delta U = 290,6 - (83) = 207,62\ J$