AUIS ENGR 352 (Thermodynamics) – Fall 2017 – Section 1

November 26, 2017

Quiz as Replacement for Assignment 3

In a **reversible Carnot refrigeration cycle** with m = 100 g of **air as the working fluid**, to be considered here as an ideal gas with the polytropic exponent $\kappa = c_p/c_v = 1.40$, the isothermal expansion occurs at a temperature of T_{low} = 250 K, during which the heat transferred to the working fluid is given by $Q_{T\,\text{low}}$ = +3.40 kJ. The isothermal compression occurs at T_{high} = 300 K, and the volume of the working fluid subsequent to the isothermal compression is $V_4 = 0.01\ \text{m}^3$.

A Carnot cycle consists of two isothermal and two adiabatic transitions. The universal gas constant is $R = 8.3145\ \text{J K}^{-1}\ \text{mol}^{-1}$, and the working fluid air has a molar mass of $M = 28.97\ \text{g mol}^{-1}$. The volumes of the states in a reversible Carnot refrigeration cycle are related by $V_2V_4 = V_1V_3$, and the ratio of the heats is given by the ratio of the temperatures, using appropriate signs.

Determine

a) the **pressure** p_1, p_2, p_3, and p_4 corresponding to each of the four states;

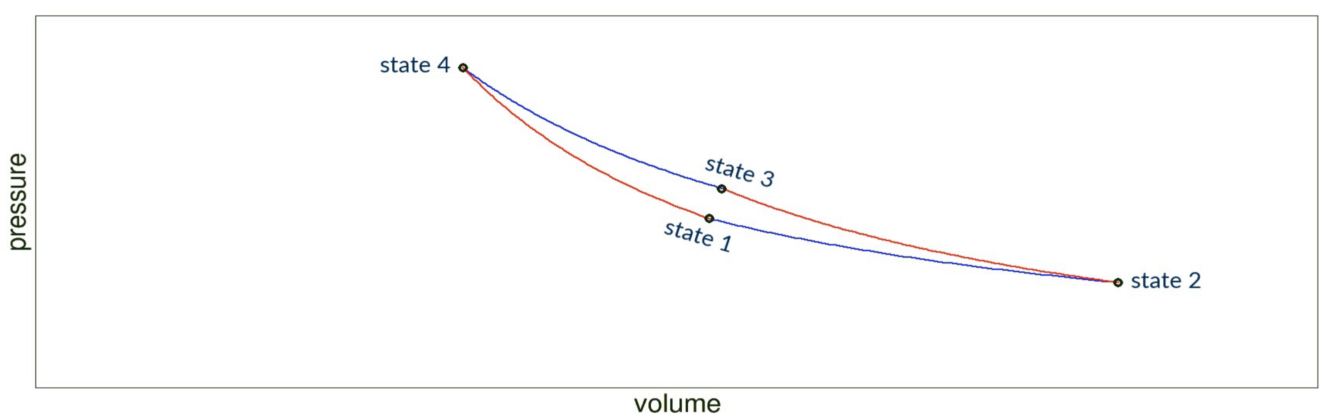
b) the **work** W_{12}, W_{23}, W_{34}, and W_{41} corresponding to each of the four transitions; state clearly whether the value that you give is the work **done to** or work **done by** the fluid;

c) the **net work** $W_{\text{net}} = W_{12} + W_{23} + W_{34} + W_{41}$ done to the fluid during as it undergoes this cycle once, and the **coefficient of performance** $\varepsilon = Q_{T\,\text{low}} / W_{\text{net}}$.

Note: It is possible to solve c) without solving a) and b) previously.

The reversible work **done to** a (stationary) system is given by $W = -\int p\,dV$.

Recall that for an ideal gas, pV^κ is constant during a transition if it is both reversible and adiabatic. Hence, combining this with the ideal gas law $pV = nRT$, since n is constant here, $p^{1-\kappa}T^\kappa$ is also constant during reversible adiabatic transitions. For isothermal transitions, pV is constant.



You have 55 minutes from the moment in which the beginning of the quiz is announced.