國立雲林科技大學 114 學年度
碩士班招生考試試題

系所：化材系
科目：化工熱力學

1. A tank of 0.4 m^3 contains nitrogen (ideal gas, M = 28 kg/kmol, $Cv = 5R/2$) at 2 MPa , 500°C. The tank is connected to an above vertical cylinder covered by a heavy piston weighted at 30 kN through a valve. The piston area is A = 0.1 m^2. The atmospheric pressure is 100 kPa. The whole tank-cylinder assembly is well insulated. At the beginning, the cylinder contains no nitrogen. Then the valve is opened and nitrogen flows into the above cylinder until the pressures in the cylinder and the tank equalize.

a. Find the final temperature in the cylinder if the final tank temperature is 250°C. (10%)

b. Find the mass of nitrogen that entered the above cylinder. (10%)

c. Find the piston rise in the process. (10%)

2. Air enters an adiabatic horizontal nozzle at P_1 = 30 bars, T_1 = 230°C, v_1 = 10 m/s, and at a rate of 2.0 kg/s. Assume air to be an ideal gas with constant $Cp = (7R/2)$ and M = 29 (kg/kmol), wherein R is gas constant.

a. Find the inlet area of nozzle. (10%)

b. Find the velocity and area at a point, wherein P_2 = 20 bars, T_2 = 180°C. (10%)

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3. Please demonstrate a Carnot cycle for an ideal gas using a PV program and explain how to derive Carnot's equation. (10%)

4. Please derive the equation of Raoult's law and explain why Henry's Law sometimes is necessary. (10%)

5. Please derive the fundamental residual property relations for Gibbs energy, entropy, and enthalpy, respectively, for a single-component gas under isothermal conditions (15%)

6. For a thermodynamic property M, we can know $nM = F(T, P, n_1, n_2, ..n_i...)$, and $\overline{Mi}$ a generic partial property. Please show us how to obtain $M = \sum x_i \overline{M_i}$ and $\sum x_i d\overline{M_i} = 0$ at constant temperature (T) and pressure (P). (15%)