1. For a real gas $P(V-b) = RT$, calculate $C_p - C_v$? (10%)

2. Sketch the possible form of an AMX NMR spectrum, where A, M, and X are protons with distinctly different chemical shift and the coupling constant of $J_{AM} > J_{AX} > J_{MX}$. (15%)

3. Calculate ΔS (for the system) when the state of 3.00 mol of perfect gas atoms, for which $C_{p,m} = 2.5\,R$, is changed from 25 °C and 1.00 atm to 125 °C and 5.00 atm. (15%)

4. Calculate the entropy change if we remove the adiabatic plate as following Figure. Assume that the $C_{p,m}$ for O_2 and N_2 gases are the same: $C_{p,m} = 29.0$ J/K.mole (20%)

Adiabatic plate

Adiabatic box

1 mol O_2	2 mol N_2
290 K	310 K
V	V
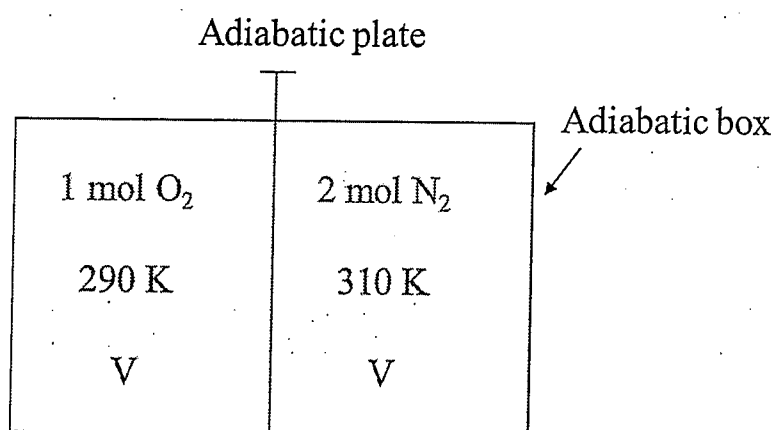
5. Calculate the change in Gibbs energy when a spherical droplet of water (1 g) disperses into the radius of 20 nm particles ($r = 20$ nm) where density of water is 1×10^3 kg.m^{-3} and the surface tension of water is 72×10^{-3} N.m^{-1} (20%)

6. Derive the rate of reaction ethane of
$C_2H_6 \Leftrightarrow C_2H_4 + H_2$

(1) Initiation: $\qquad C_2H_6 \xrightarrow{k_1} 2CH_3$

Chain transfer: $CH_3 + C_2H_6 \xrightarrow{k_2} CH_4 + C_2H_5$

(2) Propagation: $\qquad C_2H_5 \xrightarrow{k_3} C_2H_4 + H$

$\qquad\qquad H + C_2H_6 \xrightarrow{k_4} H_2 + C_2H_5$

(3) Termination: $H + C_2H_5 \xrightarrow{k_5} H_2 + C_2H_4$

We assume that k_1 is very small when compared with other rate constants.

(20%)