1. Consider the composite system, which is held at 298 K, show in the following figure. Assuming ideal gas behavior, calculate the total pressure, and the partial pressure of each component if the barriers separating the compartments are removed. Assume that the volume of barriers is negligible. (10%)

2. Calculate the pressure exerted by N₂ at 300K for molar volumes of 250 and 0.1 L using the ideal gas and the van der Waals equations of state. The values of parameters a and b for N₂ are 1.37 bar dm⁶ mol⁻² and 0.0387 dm³ mol⁻¹, respectively. (15%)

3. Calculate the work involved in expanding 20 L of an ideal gas to a final volume of 85 L against a constant external pressure of 2.5 bar. (10%)

4. 2 mol of an ideal gas undergoes isothermal expansion along two different paths: (a) reversible expansion from P₁ = 25 bar and V₁ = 4.5 L to P₂ = 4.5 bar; (b) a single-step expansion against a constant external pressure of 4.5 bar. Calculate the work for each of these processes. (10%)

5. Calculate the change in enthalpy when 124 g of liquid methanol initially at 1 bar and 298 K undergoes a change of state to 2.5 bar and 425 K. The density of liquid methanol under these conditions is 0.791 g cm⁻³, and Cₚ,m for liquid methanol is 81.1 J K⁻¹ mol⁻¹. (10%)

6. One mole of an ideal gas at 300 K is reversibly and isothermally compressed from a volume of 25 L to a volume of 10 L. Because it is very large, the temperature of the water bath thermal reservoir in the surroundings remains essentially constant at 300 K during the process. Calculate ΔS, ΔSₘᵢₓᵣᵢng and ΔSₜₒₜᵃˡ. (15%)

7. An ideal solution is made from 5 mol of benzène and 3.25 mol of toluène. Calculate ΔGₘᵢₓᵢᵣᵍ and ΔSₘᵢₓᵢᵣᵍ at 298 K and 1 bar pressure. Is mixing a spontaneous process? (10%)

8. The decomposition of N₂O₅ is an important process in tropospheric chemistry. The half-life for the first-order decomposition of this compound is 2.05×10⁴ s. How long will it take for a sample of N₂O₅ to decay to 60% of its initial value? (10%)

9. For the Daniell cell E⁰ = 1.1 V. Calculate K for the reaction

\[ \text{Zn(s)} + \text{Cu}^{2+} \text{(aq)} \rightarrow \text{Zn}^{2+} \text{(aq)} + \text{Cu(s)} \]  

(10%)